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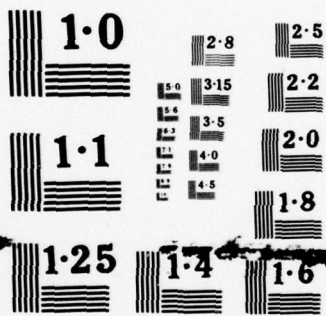
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MICROCOPY RESOLUTION TEST CHART

**LEVEL III**

**VOLUME I**

Supporting Data FY 1980  
Budget Estimate

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Submitted to CONGRESS January 1979

# Descriptive Summaries Of The



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## RESEARCH DEVELOPMENT TEST & EVALUATION

### Army Appropriation FY 1980

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DESCRIPTIVE SUMMARIES FOR PROGRAM ELEMENTS  
OF THE  
RESEARCH, DEVELOPMENT, TEST, AND EVALUATION, ARMY PROGRAM

FY 1980

JANUARY 1979

Department of the Army  
 Deputy Chief of Staff for Research, Development, and Acquisition

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## FOREWORD

These volumes have been prepared to provide information on the US Army Research, Development, Test, and Evaluation Program for Congressional Committees during the Fiscal Year 1980 hearings. This information is in addition to the testimony given by US Army witnesses.

These volumes contain a descriptive summary for each program element to be financed during FY 1980. Descriptive Summaries for projects within the program elements to be financed during FY 1980 for \$5.0 million or more appear immediately following the applicable program element. Where there are several items under development within a project, a separate summary has been provided for each item that exceeds \$5.0 million during FY 1980. A Test and Evaluation Section is provided for all major weapon systems.

There are twenty-four major weapon systems descriptive summaries appearing in Volumes II and III. Major weapon systems are identified by an asterisk in the Table of Contents. The formats and contents of these volumes are in accordance with guidelines and requirements of the Congressional Committees insofar as possible. Information previously provided in the SAC Data Book is consolidated into these volumes. The SAC Data Book information appears at the beginning of each program element descriptive summary.

A direct comparison of FY 1978, FY 1979, FY 1980, and FY 1981 data in this Program Element Listing with data shown in the Program Element Listing dated January 1978 will reveal significant differences. Many of the differences are attributable to the following factors:

- a. Restructuring of the FY 1978 and FY 1979 programs for comparability to the FY 1980 program structure.
- b. Reclassification to provide greater visibility and contribute to the effective management of the RDTE program such as the following:
  - (1) RDTE Headquarters Management.
  - (2) Further extension of the Single Program Element Funding Concept.
  - (3) Restructuring of Exploratory Development personnel RDTE programs.

The funding information used in these volumes corresponds to that contained in the President's Budget. Procurement data is shown where applicable for items in engineering or operational development. Military construction data is shown where applicable.

# TABLE OF CONTENTS

## BUDGET ACTIVITY PROGRAM ELEMENT PROJECT/SCIENTIFIC AREA/TECHNICAL AREA

### VOLUME I

#### TECHNOLOGY BASE

6.11.01.A  
6.11.02.A  
AH43  
AH45  
BH57  
BH57-03  
BH57-07  
AH60  
BS01  
A31B  
6.21.05.A  
6.21.11.A  
6.21.20.A  
6.22.01.A  
6.22.02.A  
6.22.09.A  
6.22.10.A  
6.23.03.A  
6.23.07.A  
6.26.01.A  
6.26.03.A  
6.26.17.A  
6.26.18.A  
6.26.22.A  
6.27.01.A  
6.27.03.A  
6.27.04.A  
6.27.05.A  
6.27.06.A

IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR). . . . .  
DEFENSE RESEARCH SCIENCES. . . . .  
RESEARCH IN BALLISTICS . . . . .  
AIR MOBILITY RESEARCH. . . . .  
RESEARCH IN SCIENTIFIC PROBLEMS WITH MILITARY APPLICATIONS . . . . .  
COMMUNICATIONS ENGINEERING AND ELECTRONICS . . . . .  
PHYSICS. . . . .  
RESEARCH IN LARGE CALIBER ARMAMENTS. . . . .  
BASIC RESEARCH ON MILITARY INJURY AND DISEASES . . . . .  
NIGHT VISION AND ELECTROOPTICS RESEARCH. . . . .  
MATERIALS. . . . .  
ATMOSPHERIC INVESTIGATIONS . . . . .  
NUCLEAR WEAPONS EFFECTS, FLUIDICS. . . . .  
AIRCRAFT WEAPONS TECHNOLOGY. . . . .  
AIRCRAFT AVIONICS TECHNOLOGY . . . . .  
AERONAUTICAL TECHNOLOGY. . . . .  
AEROSPACE TECHNOLOGY . . . . .  
MISSILE TECHNOLOGY . . . . .  
HIGH ENERGY LASER (HEL) TECHNOLOGY . . . . .  
TANK AND AUTOMOTIVE TECHNOLOGY . . . . .  
LARGE CALIBER AND NUCLEAR TECHNOLOGY . . . . .  
SMALL CALIBER & FIRE CONTROL TECHNOLOGY. . . . .  
BALLISTICS TECHNOLOGY. . . . .  
CHEMICAL MUNITIONS AND CHEMICAL COMBAT SUPPORT . . . . .  
COMMUNICATION - ELECTRONICS. . . . .  
COMBAT SURVEILLANCE, TARGET ACQUISITION AND IDENTIFICATION . . . . .  
MILITARY ENVIRONMENTAL CRITERIA DEVELOPMENT. . . . .  
ELECTRONICS AND ELECTRON DEVICES . . . . .  
CHEMICAL BIOLOGICAL DEFENSE AND GENERAL INVESTIGATION. . . . .

#### PAGE NO.

I-1  
I-10  
I-24  
I-27  
I-31  
I-35  
I-39  
I-43  
I-46  
I-50  
I-54  
I-59  
I-64  
I-69  
I-73  
I-78  
I-83  
I-86  
I-99  
I-106  
I-111  
I-116  
I-120  
I-125  
I-130  
I-137  
I-142  
I-148  
I-156



BUDGET ACTIVITY  
PROGRAM ELEMENT  
PROJECT/SCIENTIFIC AREA/TECHNICAL AREA

TECHNOLOGY BASE (Continued)

PAGE NO.

6.27.07.A	MAPPING AND GEODESY . . . . .	1-160
6.27.09.A	NIGHT VISION INVESTIGATIONS . . . . .	1-164
6.27.15.A	TACTICAL ELECTRONIC WARFARE TECHNOLOGY . . . . .	1-168
A042	ELECTRONIC WARFARE TECHNOLOGY . . . . .	1-173
6.27.16.A	HUMAN FACTORS ENGINEERING IN SYSTEMS DEVELOPMENT . . . . .	1-177
6.27.17.A	HUMAN PERFORMANCE EFFECTIVENESS AND SIMULATION . . . . .	1-180A
6.27.19.A	MOBILITY & WEAPONS EFFECTS TECHNOLOGY . . . . .	1-184
6.27.20.A	ENVIRONMENTAL QUALITY TECHNOLOGY . . . . .	1-189
6.27.22.A	MANPOWER, PERSONNEL AND TRAINING . . . . .	1-194
6.27.23.A	CLOTHING, EQUIPMENT AND SHELTER TECHNOLOGY . . . . .	1-198
6.27.24.A	JOINT SERVICES FOOD SYSTEM TECHNOLOGY . . . . .	1-203
6.27.25.A	COMPUTER AND INFORMATION SCIENCES . . . . .	1-207
6.27.26.A	ARMY SUPPORT OF THE DEFENSE ADVANCED RESEARCH PROJECT AGENCY (DARPA) . . . . .	1-213
6.27.27.A	NON-SYSTEMS TRAINING DEVICES (NSTD) TECHNOLOGY . . . . .	1-217
6.27.30.A	COLD REGIONS ENGINEERING TECHNOLOGY . . . . .	1-222
6.27.31.A	MILITARY FACILITIES ENGINEERING TECHNOLOGY . . . . .	1-227
6.27.32.A	REMOTELY PILOTED VEHICLES (RPV) SUPPORTING TECHNOLOGY . . . . .	1-232
6.27.33.A	MOBILITY EQUIPMENT TECHNOLOGY . . . . .	1-237
6.27.34.A	MEDICAL DEFENSE AGAINST CHEMICAL AGENTS . . . . .	1-242
6.27.70.A	MILITARY INFECTIOUS DISEASE TECHNOLOGY . . . . .	1-245
A802	MILITARY PREVENTIVE MEDICINE . . . . .	1-250
6.27.71.A	MILITARY PSYCHIATRY AND MICROWAVE INJURY . . . . .	1-254
6.27.72.A	RECOVERY FROM INJURY . . . . .	1-258
6.27.73.A	HELICOPTER COMBAT CREW AND AIRBORNE MEDICINE . . . . .	1-262
6.27.75.A	COMBAT MAXILLOFACIAL INJURY . . . . .	1-266
6.27.76.A	MEDICAL DEFENSE AGAINST BIOLOGICAL AGENTS . . . . .	1-270
6.27.77.A	MILITARY ENVIRONMENTAL STRESS . . . . .	1-276
6.27.78.A	COMBAT MEDICAL MATERIEL . . . . .	1-281
6.27.79.A	TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT TECHNOLOGY . . . . .	1-284
6.27.80.A	MEDICAL SYSTEMS IN CHEMICAL DEFENSE . . . . .	1-287
6.27.81.A	MILITARY ENERGY TECHNOLOGY . . . . .	1-289
6.27.82.A	VERY HIGH SPEED INTEGRATED CIRCUITS . . . . .	1-293
6.31.02.A	MATERIALS SCALE-UP . . . . .	1-294
6.31.04.A	FUELS & EQUIPMENT . . . . .	1-298

BUDGET ACTIVITY  
PROGRAM ELEMENT  
PROJECT/SCIENTIFIC AREA/TECHNICAL AREA

VOLUME I

TECHNOLOGY BASE (Continued)

		PAGE NO.
6.32.01.A	AIRCRAFT POWER PLANTS AND PROPULSION.	I-300
D447	DEMONSTRATOR ENGINES.	I-304
6.32.06.A	AIRCRAFT WEAPONS.	I-308
6.32.07.A	AIRCRAFT AVIONICS EQUIPMENT	I-312
6.32.09.A	AIR MOBILITY SUPPORT.	I-315
6.32.11.A	ROTARY WING CONTROLS, ROTORS, AND STRUCTURES.	I-319
6.32.16.A	SYNTHETIC FLIGHT SIMULATORS	I-324
6.32.18.A	AIRDROP EQUIPMENT AND TECHNIQUES.	I-328
6.33.06.A	TERMINAL HOMING SYSTEMS	I-332
6.33.13.A	MISSILE/ROCKET COMPONENTS	I-336
6.33.14.A	HIGHER ENERGY LASER (HEL) COMPONENTS.	I-341
6.36.02.A	ADVANCED LAND MOBILITY SYSTEM CONCEPTS.	I-348
D188	HIGH SURVIVABILITY TEST VEHICLE	I-352
6.36.06.A	LANDMINE WARFARE.	I-355
6.36.07.A	ARMY SMALL ARMS PROGRAM	I-359
6.36.13.A	ADVANCED FUZE DESIGN.	I-363
6.36.18.A	COUNTERMINE AND BARRIERS DEVELOPMENT.	I-367
6.36.21.A	COMBAT VEHICLE PROPULSION SYSTEMS	I-371
6.36.31.A	COMBAT VEHICLE TURRET & CHASSIS	I-375
6.37.02.A	ELECTRIC POWER SOURCES.	I-380
6.37.09.A	ADVANCED TECHNOLOGY DEMONSTRATION OF TMDE	I-384
6.37.10.A	NIGHT VISION ADVANCED DEVELOPMENT	I-388
DK70	NIGHT VISION ADVANCED DEVELOPMENT	I-393
6.37.25.A	REMOTELY PILOTED VEHICLES (RPV'S)/DRONES.	I-395
6.37.31.A	MANPOWER AND PERSONNEL.	I-400
6.37.32.A	COMBAT MEDICAL MATERIEL	I-404
6.37.39.A	HUMAN FACTORS IN TRAINING AND OPERATIONAL EFFECTIVENESS	I-406
6.37.42.A	ADVANCED ELECTRONIC DEVICES	I-410
6.37.43.A	EDUCATION AND TRAINING.	I-415
6.37.44.A	TRAINING SIMULATION	I-419
6.37.48.A	ADVANCED DEVELOPMENT OF AUTOMATIC TEST EQUIPMENT AND SYSTEMS.	I-423
6.37.49.A	TECHNICAL VULNERABILITY REDUCTION	I-427
6.37.50.A	DRUG & VACCINE DEVELOPMENT.	I-432

BUDGET ACTIVITY  
PROGRAM ELEMENT  
PROJECT/TASK/TECHNICAL AREA

VOLUME II

STRATEGIC PROGRAMS

6.33.04.A	BALLISTIC MISSILE DEFENSE ADVANCED TECHNOLOGY . . . . .	II-1
6.33.08.A	BALLISTIC MISSILE DEFENSE SYSTEMS TECHNOLOGY PROGRAM (BMDSTP) . . . . .	II-6
6.37.35.A	WORLDWIDE MILITARY COMMAND AND CONTROL SYSTEM (WWMCCS) ARCHITECTURE . . . . .	II-11
3.31.45.A	EUCOM COMMAND, CONTROL, AND COMMUNICATIONS SYSTEMS (EUCOM C3 SYSTEMS) . . . . .	II-15

TACTICAL PROGRAMS

6.32.15.A	JOINT SURVIVABILITY INVESTIGATIONS . . . . .	II-19
6.33.03.A	SURFACE-TO-SURFACE MISSILE ROCKET SYSTEMS . . . . .	II-22
D564 *	AREA FIRE SUPPORT ROCKET - GENERAL SUPPORT ROCKET SYSTEM . . . . .	II-28
6.33.20.A	ASSAULT BREAKER . . . . .	II-35
6.36.04.A	NUCLEAR MUNITIONS AND RADIACS . . . . .	II-40
6.36.08.A	WEAPONS & AMMUNITION . . . . .	II-45
6.36.12.A	ANTITANK GUIDED MISSILE IMPROVEMENTS . . . . .	II-49
6.36.15.A	LETHAL CHEMICAL MUNITIONS CONCEPTS . . . . .	II-53
6.36.19.A	COUNTERMINE AND BARRIERS . . . . .	II-57
6.36.23.A	LANDMINE SYSTEMS . . . . .	II-60
6.36.24.A	MOBILITY . . . . .	II-62
6.36.27.A	COMBAT SUPPORT MUNITIONS . . . . .	II-65
6.36.28.A	FIELD ARTILLERY AMMUNITION DEVELOPMENT . . . . .	II-69
D007	FIELD ARTILLERY AMMUNITION DEVELOPMENT . . . . .	II-73
6.36.29.A	ARMED COMBAT SUPPORT VEHICLE FAMILY . . . . .	II-75
6.36.32.A	PHYSICAL SECURITY . . . . .	II-79
6.37.05.A	IDENTIFICATION FRIEND-OR-FOE (IFF) DEVELOPMENTS . . . . .	II-83
6.37.06.A	COMMUNICATIONS DEVELOPMENT . . . . .	II-88
6.37.07.A	AIRCRAFT ELECTRONIC WARFARE (EW) SELF-PROTECTION EQUIPMENT . . . . .	II-93
6.37.11.A	MAPPING AND GEODESY . . . . .	II-98
6.37.12.A	SPECIAL PURPOSE DETECTORS . . . . .	II-103
6.37.19.A	CHEMICAL DEFENSIVE MATERIEL CONCEPTS . . . . .	II-107
6.37.21.A	CHEMICAL DEFENSIVE MATERIEL CONCEPTS . . . . .	II-110



BUDGET ACTIVITY  
PROGRAM ELEMENT  
PROJECT/TASK/TECHNICAL AREA

VOLUME II

TACTICAL PROGRAMS (Continued)

PAGE NO.

DE81	CHEMICAL DECONTAMINATION MATERIEL	II-114
6.37.22.A	TACTICAL OPERATIONS SYSTEM (TOS)	II-116
6.37.23.A	COMMAND AND CONTROL	II-122
6.37.26.A	COMBAT SUPPORT EQUIPMENT	II-127
6.37.30.A	TACTICAL SURVEILLANCE SYSTEM	II-131
6.37.37.A	ANTI-RADIATION MISSILE COUNTERMEASURES (ARM-CH)	II-134
6.37.40.A	SHORT RANGE AIR DEFENSE COMMAND AND CONTROL (SHORAD-C <sup>2</sup> ) SYSTEMS	II-138
6.37.45.A	TACTICAL ELECTRONIC WARFARE EQUIPMENT	II-144
D907	TACTICAL ELECTRONIC SURVEILLANCE SYSTEM	II-148
6.37.46.A *	SINGLE CHANNEL GROUND AND AIRBORNE RADIO SYSTEM (SINGCARS)	II-150
6.37.55.A	TACTICAL ELECTRONIC COUNTERMEASURES SYSTEMS	II-156
DK12	DIVISION TACTICAL ELECTRONIC COUNTERMEASURES SYSTEMS	II-161
6.42.01.A	AIRCRAFT AVIONICS	II-165
6.42.02.A	AIRCRAFT WEAPONS	II-169
6.42.03.A *	AERIAL SCOUT	II-173
6.42.04.A	AIR MOBILITY SUPPORT EQUIPMENT	II-178
6.42.07.A *	ADVANCED ATTACK HELICOPTER	II-182
6.42.12.A	COBRA/TOW	II-191
6.42.13.A *	CH-47 MODERNIZATION	II-195
6.42.17.A	SYNTHETIC FLIGHT TRAINING SYSTEMS	II-202
6.42.18.A	AIRDROP EQUIPMENT DEVELOPMENT	II-206
6.43.06.A *	STINGER	II-210
6.43.07.A	PATRIOT (SAM-D)	II-218
D212	PATRIOT (SAM-D)	II-224
6.43.08.A	PRECISION LASER DESIGNATOR	II-232
6.43.09.A *	ROLAND	II-236
6.43.10.A *	HELIBORNE MISSILE - HELLFIRE	II-245
6.43.11.A *	PERSHING II	II-255
6.43.13.A	GRASS BLADE	II-263
6.43.16.A *	FIRE AND FORGET HELLFIRE	II-265
6.43.18.A *	DIVISION AIR DEFENSE (DIVAD) GUN	II-271

BUDGET ACTIVITY  
PROGRAM ELEMENT  
PROJECT/TASK/TECHNICAL AREA

VOLUME II

TACTICAL PROGRAMS (Continued)

PAGE NO.

6.46.01.A	INFANTRY SUPPORT WEAPONS	11-279
6.46.02.A	WEAPONS AND AMMUNITION	11-285
6.46.03.A	NUCLEAR MUNITIONS	11-290
D385	IMPROVED 155MM NUCLEAR PROJECTILE	11-296
6.46.05.A	FIELD ARTILLERY WEAPONS AND AMMUNITION, 105MM	11-301
6.46.06.A	EXPLOSIVE DEMOLITIONS	11-305
6.46.08.A	ARMY SMALL ARMS PROGRAM	11-309
6.46.09.A	COMBAT SUPPORT SYSTEMS	11-313
6.46.12.A	COUNTERMINE AND BARRIERS	11-317
6.46.14.A	FIELD ARTILLERY WEAPONS AND AMMUNITION, 155MM	11-322
D373	AMMUNITION, CANNON, 155MM	11-326
6.46.16.A *	INFANTRY FIGHTING VEHICLE (IFV) XM2	11-329
6.46.17.A *	VEHICLE RAPID FIRE WEAPON SYSTEM (VRFS) - (BUSHMASTER)	11-338
6.46.19.A	LANDMINE WARFARE	11-346
D088	MODULAR PACK MINE SYSTEM	11-351
6.46.20.A *	TANK SYSTEMS	11-354
6.46.21.A *	COPPERHEAD (CANNON LAUNCHED GUIDED PROJECTILE)	11-362
6.46.23.A	IMPROVED LIGHT ANTITANK WEAPON (VIPER)	11-369
6.46.24.A	HIGH MOBILITY WEAPONS CARRIER	11-373
6.46.26.A	FORWARD OBSERVER VEHICLE	11-377
6.46.28.A	INDIRECT FIRE TRAINING MUNITIONS	11-381
6.46.29.A *	CAVALRY FIGHTING VEHICLE (CFV) XM3	11-385
6.46.30.A	TANK GUN COOPERATIVE DEVELOPMENT	11-393
D064	120MM TANK GUN AMMO DEVELOPMENT	11-398
D287	TANK GUN INTEGRATION	11-402

BUDGET ACTIVITY  
PROGRAM ELEMENT  
PROJECT/SCIENTIFIC AREA/TECHNICAL AREA

VOLUME III

TACTICAL PROGRAMS

PAGE NO.

6.47.01.A	COMMUNICATIONS ENGINEERING DEVELOPMENT . . . . .	III-1
6.47.04.A	UNATTENDED GROUND SENSORS (UGS) . . . . .	III-7
6.47.06.A	RADIOLOGICAL DEFENSE EQUIPMENT . . . . .	III-11
6.47.09.A	IDENTIFICATION FRIEND OR FOE (IFF) EQUIPMENT . . . . .	III-15
6.47.10.A	NIGHT VISION DEVICES . . . . .	III-19
6.47.11.A	AIRCRAFT ELECTRONIC WARFARE (EW) SELF-PROTECTION SYSTEMS . . . . .	III-23
D665	SPECIAL ELECTRONIC MISSION AIRCRAFT SURVIVABILITY SYSTEMS . . . . .	III-28
6.47.12.A	TACTICAL DATA SYSTEM INTEROPERABILITY . . . . .	III-31
6.47.14.A	TACTICAL ELECTRIC POWER SOURCES . . . . .	III-36
6.47.16.A	MAPPING AND GEODESY . . . . .	III-40
6.47.17.A	GENERAL COMBAT SUPPORT . . . . .	III-45
6.47.18.A	PHYSICAL SECURITY . . . . .	III-50
6.47.23.A	SPECIAL PURPOSE DETECTORS . . . . .	III-55
6.47.24.A	BIOLOGICAL DEFENSE MATERIAL . . . . .	III-58
6.47.25.A	CHEMICAL DEFENSE MATERIEL . . . . .	III-61
1023	COLLECTIVE PROTECTION MATERIEL - ARMORED VEHICLES . . . . .	III-66
6.47.27.A	COMMAND AND CONTROL . . . . .	III-68
DC98	POSITION LOCATION REPORTING SYSTEM (PLRS) . . . . .	III-75
6.47.28.A	FAMILY OF MILITARY ENGINEER CONSTRUCTION EQUIPMENT (FAMECE) . . . . .	III-79
6.47.29.A	COUNTERMORTAR RADAR (AN/TPQ-36) . . . . .	III-82
6.47.30.A	REMOTELY PILOTED VEHICLES (RPVs) . . . . .	III-87
6.47.31.A *	COUNTERBATTERY RADAR (AN/TPQ-37) . . . . .	III-91
6.47.40.A	TACTICAL SURVEILLANCE SYSTEM . . . . .	III-99
6.47.45.A	TACTICAL ELECTRONIC WARFARE SYSTEMS . . . . .	III-102
D906	DIVISION TACTICAL ELECTRONIC SUPPORT MEASURES SYSTEMS . . . . .	III-106
D909	TACTICAL ELECTRONIC SURVEILLANCE SYSTEM . . . . .	III-109
6.47.48.A *	STANDOFF TARGET ACQUISITION SYSTEM (SOTAS) . . . . .	III-112
6.47.50.A	TACTICAL ELECTRONIC COUNTERMEASURES SYSTEMS . . . . .	III-121
DL12	DIVISION TACTICAL ELECTRONIC COUNTERMEASURES SYSTEMS . . . . .	III-125
6.47.78.A	NAVSTAR GLOBAL POSITIONING SYSTEM (GPS) USER EQUIPMENT . . . . .	III-128
6.47.79.A	JOINT INTEROPERABILITY OF TACTICAL COMMAND AND CONTROL SYSTEMS (JINTACCS) . . . . .	III-132
D309	JOINT INTEROPERABILITY OF TACTICAL COMMAND AND CONTROL SYSTEMS (ARMY) . . . . .	III-137
D310	JOINT INTEROPERABILITY OF TACTICAL COMMAND AND CONTROL SYSTEMS (EXECUTIVE AGENT) . . . . .	III-144
6.57.10.A	JOINT CHEMICAL/BIOLOGICAL CONTACT POINT AND TEST . . . . .	III-148

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BUDGET ACTIVITY  
PROGRAM ELEMENT  
PROJECT/SCIENTIFIC AREA/TECHNICAL AREA

VOLUME III

TACTICAL PROGRAMS (Continued)

PAGE NO.

6.57.13.A	BATTLEFIELD SYSTEMS INTEGRATION.	III-152
2.37.24.A *	HEAVY ANTITANK/ASSAULT WEAPON SYSTEM (TOW)	III-155
2.37.30.A *	CHAPARRAL.	III-164
2.37.31.A *	SURFACE-TO-AIR MISSILE HAWK/HAWK IMPROVEMENT PROGRAM (SAM HAWK/HIP)	III-176
2.37.33.A *	IMPROVED NONNUCLEAR LANCE WARHEAD SECTION.	III-185
2.37.35.A	M60A1 TANK PRODUCT IMPROVEMENT PROGRAM	III-193
2.80.10.A	JOINT TACTICAL COMMUNICATIONS PROGRAM (TRI-TAC)	III-198
D104	JOINT TACTICAL COMMUNICATIONS (TRI-TAC) OFFICE	III-205
D119	MODULAR RECORD TRAFFIC TERMINAL (MRTT)	III-210
D222 *	AUTOMATIC COMMUNICATIONS CENTRAL OFFICE, AN/TTC-39	III-213

INTELLIGENCE AND COMMUNICATION

3.31.11.A	STRATEGIC COMMUNICATIONS (STARCOM)	III-221
3.31.26.A	LONG HAUL COMMUNICATION (DCS)	III-224
3.31.42.A	SATELLITE COMMUNICATIONS GROUND ENVIRONMENT.	III-228
D253	DEFENSE SATELLITE COMMUNICATIONS SYSTEM-DEFENSE COMMUNICATION SYSTEM (PHASE II)	III-234
D456	TACTICAL SATELLITE COMMUNICATION SYSTEMS	III-238
3.34.01.A	COMMUNICATIONS SECURITY (COMSEC) EQUIPMENT	III-241

DEFENSEWIDE MISSION SUPPORT

6.33.15.A	TARGET MISSILES.	III-245
6.37.18.A	ELECTRONIC WARFARE VULNERABILITY/SUSCEPTIBILITY.	III-250
D267	MISSILE VULNERABILITY/SUSCEPTIBILITY	III-256
6.37.38.A	NONSYSTEMS TRAINING DEVICES (NSTD) DEVELOPMENT	III-260
A224	NSTD ARMOR/ANTIARMOR	III-266
6.37.47.A	SOLDIER SUPPORT/SURVIVABILITY.	III-269
6.47.13.A	COMBAT FEEDING, CLOTHING, AND EQUIPMENT.	III-273
6.47.15.A	NON-SYSTEMS TRAINING DEVICES (NSTD) ENGINEERING.	III-277
6.47.26.A	METEOROLOGICAL EQUIPMENT AND SYSTEMS	III-284
6.51.02.A	US ARMY TRAINING AND DOCTRINE COMMAND (TRADOC) STUDIES AND ANALYSES.	III-288
6.52.01.A	AVIATION ENGINEERING FLIGHT ACTIVITY	III-291
6.53.01.A	KWAJALEIN MISSILE RANGE.	III-294

BUDGET ACTIVITY  
PROGRAM ELEMENT  
PROJECT/SCIENTIFIC AREA/TECHNICAL AREA

DEFENSEWIDE MISSION SUPPORT (Continued)		VOLUME III	PAGE NO.
6.57.02.A	SUPPORT OF DEVELOPMENT TESTING . . . . .		III-299
D618	AIRCRAFT DEVELOPMENT TEST ACTIVITY. . . . .		III-306
6.57.06.A	MATERIEL SYSTEMS ANALYSIS . . . . .		III-308
6.57.07.A	US ARMY TRAINING AND DOCTRINE COMMAND (TRADOC) OPERATIONAL TESTING. . . . .		III-312
DV02	TEST BOARDS . . . . .		III-317
DV03	INITIAL OPERATIONAL TEST AND EVALUATION (IOTE). . . . .		III-320
D986	SUPPORT EQUIPMENT . . . . .		III-323
6.57.08.A	THEATER NUCLEAR FORCE SURVIVABILITY (TNF/S) ANALYSIS. . . . .		III-326
6.57.09.A	EXPLOITATION OF FOREIGN ITEMS . . . . .		III-329
6.57.12.A	US ARMY OPERATIONAL TEST AND EVALUATION AGENCY (OTEA) OPERATIONAL TESTING. . . . .		III-333
6.58.01.A	PROGRAMWIDE ACTIVITIES. . . . .		III-337
M488-01	COMMAND HEADQUARTERS SUPPORT. . . . .		III-341
M488-03	SPECIAL PURPOSE AND AUTOMATIC DATA PROCESSING EQUIPMENT . . . . .		III-343
6.58.02.A	INTERNATIONAL COOPERATIVE RESEARCH AND DEVELOPMENT. . . . .		III-345
6.58.03.A	TECHNICAL INFORMATION ACTIVITIES. . . . .		III-348
6.58.04.A	US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND (DARCOM) RANGES/TEST FACILITIES. . . . .		III-352
DE90	YUMA PROVING GROUND . . . . .		III-357
DE91	ABERDEEN PROVING GROUND (MATERIEL TEST DIRECTORATE) . . . . .		III-360
DE92	DUCHWAY PROVING GROUND . . . . .		III-363
DE93	WHITE SANDS MISSILE RANGE . . . . .		III-366
DE94	ARMY ELECTRONIC PROVING GROUND. . . . .		III-369
6.58.05.A	DOD MUNITIONS EFFECTIVENESS AND EXPLOSIVE SAFETY. . . . .		III-372
6.58.98.A	ARMY MANAGEMENT HEADQUARTERS ACTIVITIES . . . . .		III-377

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.11.01.A  
DoD Mission Area: #110 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs	Not Applicable
A91	In-House Laboratory	14692	16000	17500	18400	Continuing	Not Applicable	Not Applicable
<b>TOTAL FOR PROGRAM ELEMENT</b>		<b>14692</b>	<b>16000</b>	<b>17500</b>	<b>18400</b>			

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides Army RDTE activity directors the opportunity to perform highly promising and innovative research without having to acquire formal approval and subsequent funding. It is one of several measures used to strengthen scientific and engineering competence, improve morale, aid scientific and technical personnel recruitment and retention, and facilitate communication and interaction within the scientific community. Not only does this program provide the resources and interaction with the flexibility to respond quickly to new technical challenges, it also serves as a wellspring for innovative and imaginative ideas, of which the more promising ones progress into development programs. Approximately 500 research and development tasks were pursued in FY 1978.

C. BASIS FOR FY 1980 RDTE REQUEST: This request is based on the opinion that this program is important to Army laboratories and should be provided modest real growth. Funds are allocated directly to Directors of participating laboratories by the Assistant Secretary of the Army (Research, Development and Acquisition) and are not subject to reallocation by intervening echelons. This allocation is based on a review of the use of funds and of the accomplishments during the preceding fiscal year.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Cost	Not Applicable
	14722	16000	17500	Continuing		

The \$30 thousand reduction in FY 1978 was used to support an armed forces orientation to engineering careers program under program element 6.58.03.A, Technology Information Activities.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.11.01.A  
DoD Mission Area: #110 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: This program promotes creativity, innovation, efficiency, improved morale, and recruitment/retention of scientists and engineers by providing funds to maintain or increase individual professional competence through original work relevant to assigned military missions. It also provides a vehicle whereby innovative, high risk ideas with possible high payoff can be pursued to the benefit of the Army and Army scientists. That is, this program is keyed to increasing innovative creativity and professional competence.

G. RELATED ACTIVITIES: The Navy and Air Force have similar programs. Coordination is accomplished through scientific symposia, literature reviews, exchange of research and technology resumes, and Department of Defense topical reviews.

H. WORK PERFORMED BY: In-House Laboratory Independent Research is performed in thirty-seven Army RDTE activities.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments:

a. The in-flight acoustic measurement technique previously developed under ILIR by the Research and Technology Laboratories is the only method by which full-scale, far-field helicopter noise signatures can be measured that are free of distortion from reverberation. This technique has made possible the acquisition of essential reference data for comparison of theoretical calculations and for determining the effects of scale and artificial boundary conditions. During FY 1978, small-scale rotor tests in the 7 by 10 feet wind tunnel were shown to provide accurate, high-speed rotor impulsive noise measurements provided proper consideration is given to the effect of the tunnel walls. That is, these measurements correlate extremely well with in-flight data. This fortunate situation allows less expensive testing and is significantly beneficial because specialized instrumentation can be used in the wind tunnel to study the flow physics and greatly enhance the understanding of the rotor noise generation process. This will lead to understanding rotor generated noise at less expense and will permit developing better specifications, design trade-offs, and reduced noise rotors at lower cost.

b. The Army Engineer Topographic Laboratories conducted research in signal signatures of topographic features from aerial photography using analog technology. This pattern recognition and identification stands as a good step forward in automatic feature extraction. Additional research is planned to increase the number of identifiable features. If successfully developed it will reduce the time a photo-interpreter, using present methods, would devote to pattern recognition and feature extraction from several hours to only a few minutes.

c. The US Army Waterways Experiment Station conducted studies on oxidation-reduction in anaerobic sediments and natural waterways. The forecasting capability of the oxidation reduction in anaerobic sediments and natural water systems directly affects Corps of Engineers Civil Works activities since the intensity and extent determines the form and mobility of many

Program Element: #6.11.01.A  
DOD Mission Area: #110 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)  
Budget Activity: #1 - Technology Base

chemical constituents which in turn impact on environmental systems. It was found that small scale experiments on the oxidation-reduction rates can be extrapolated to field test size reactions. These results are being used in a preimpoundment study of the proposed Twin Valley Lake. Additional projects utilizing the oxidation-reduction of anaerobic element hypothesis will range from the prediction of the effects of anaerobic conditions on the mobilization of contaminants from highly contaminated dredged sediments under various disposal practices to the effects of anaerobic conditions on long-term underground disposal of wastes containing long-lived radionuclides.

d. The Army Construction Engineering Research Laboratory conducted studies on basic analytical relationships for ecological studies. The problem was to predict the magnitude and extent of impact resulting from Army training activities using tracked vehicles. A practical set of systematic procedures for field collection of terrestrial data was developed and the viability of the "Guild" concept was demonstrated. Data on small mammals that exploit the same class of environmental resources (a Guild) were collected at three sites--a newly prepared training site, an active training site and an undisturbed site. Comparison of gathered data provides strong statistical support that all guild members are affected in the same manner. This finding then allows data to be gathered on only one guild member to predict the impact on all members. Furthermore, likely species impacts can be predicted from knowledge of the environmental resources in an area. It appears that this concept can be applied to other areas such as birds and vegetation.

e. Large Caliber Weapon Systems Laboratory conducted investigations in the area of high temperature metal-matrix composites resulting in the successful incorporation of tungsten filaments in a depleted uranium matrix, using vacuum infiltration techniques. Although much remains to be done in terms of property and fiber orientation optimization, the study of the reaction zone and potential coatings to protect the filament, the results indicate that the technique has a high potential of being a practical approach to improving penetration performance of kinetic energy penetrator materials. This research will be continued as part of the regular technology base program of the laboratory.

f. Dugway Proving Ground undertook research to characterize microbial aerosols generated as a result of agricultural processing and waste disposal procedures for possible use in the future development and evaluation of biological defense measures, and to assess the density and composition of these incidental aerosols. Aerosol sampling equipment was used to sample microbial aerosols downwind of waste water spray fields to provide measures of cloud density, particle size distribution, composition, and degradation with downwind travel. The results of the study have established that aerosol particles bearing microorganisms are produced when food processing wastes are sprayed on a disposal field. The area source diffusion model fairly accurately predicted the measured downwind concentrations. Evidence is that at least during summer months, aerosol cloud travel during daylight would not be extensive due to rapid dispersion of the cloud in the unstable atmosphere. Though not confirmed, it is likely that microbial decay would be appreciable during daylight hours due to exposure of the organisms to ultraviolet radiation. At night when wind did develop during periods of atmospheric stability the aerosol particles travelled downwind but the concentration reached a dilution level that was indistinguishable from background or control concentration at a distance of 10 kilometers. Tripling concentrations tripled dilution distances to 25-30 kilometers.



Program Element: #6.11.01.A

DoD Mission Area: #110 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)

Budget Activity: #1 - Technology Base

g. Ballistic Research Laboratory research in within-the-bore boundary layer measurements developed a multiple discharge technique that has been successfully used for velocity profile measurements in wind tunnel and ballistic range tests. This novel technique should allow measurement of velocity profiles on the interior wall of a gun tube for the first time. These measurements will be used for validation of viscous interior ballistic models being developed in other tasks which may lead to new insights about the wear and erosion processes. The technique adapted involves firing a sequence of high voltage discharges across a fixed electrode gap while a flow phenomena of interest occurs between them. The first spark generates an ionized path in the fluid. The path is convected downstream by the flow and successive sparks, following the path of least resistance, strike across the ionized trail. By observing the spark sequence with an open shutter camera, it is possible to determine flow velocity profiles. Tests have demonstrated spark discharge and optically recorded the ionized trail in the gases. A theoretical analysis has provided distortion effects studies and corrective values. Future plans involve fabrication of a muzzle attachment with improved optics in an attempt to resolve boundary layer velocity profiles. This work will continue in FY 1979.

h. At the Army Materials and Mechanics Research Center, investigations on chemical and thermal shrinkage stress in fiber reinforced composites produced some surprising results. One normally tries to achieve slow cooling of materials to allow stresses to relieve themselves through flow and reorientation, but these investigations showed that slow cooling increases residual stresses and caused property degradation in glass-epoxy laminates. Rapidly quenched material is definitely superior in its properties. Further studies will be undertaken under the regular technology base program to elucidate the mechanisms involved. Other studies in determining the feasibility of lightweight, composite gun barrel construction, showed that stress supporting sleeves to prevent muzzle droop, currently made of steel, can be made of composites with a 60%-70% weight savings and possibly improve performance.

i. White Sands Missile Range (WSMR) supported research in the theory of the distributed feedback (DFB) laser including gain saturation. The research objective was to develop the theory, a mathematical model and a computer program that will describe the behavior of the distributed feedback laser considering the dependence of gain of the laser on the irradiance of the medium. The theory was developed and debugging of a computer program started in FY 1977. The WSMR computer program used in distributed feedback calculations was adapted to the eclipse computer system at the University of Arizona to take advantage of the University's graphics capabilities. The model has been successfully installed and is working. A paper that relates numerically the decrease in distributed feedback laser output because of spatial hole burning was prepared. A report treating off-resonance cases of laser operation is being prepared. The primary investigator will work with Air Force weapons laboratory scientists on applications to the problem of real-time wavefront correction for high-energy laser weapons and laser instrumentation systems.

j. Electronics Technology and Devices Laboratory selected gallium arsenide as one of the most promising fields for probing research exploration/exploitation with the ultimate purpose of developing a practical information base on this material and on its potential application to a needed new family of high speed devices. Immediate system application was made of the theoretical findings in the "crossed field amplifier (CFA) space charge flow" studies dealing with the subtle causes of



Program Element: #6.11.01.A

DoD Mission Area: #110 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)

Budget Activity: #1 - Technology Base

crossed field amplifier tube malfunction in Army systems. The theory-predicted causes of malfunction were successfully used to make a corrective redesign of a crossed field amplifier tube in the PATRIOT system and will be extended to another tube manufacturer's design for this weapons system. In another area, a unique, very low power "millimeter wave shifter" design was developed and prototyped. A second-phase of this effort to remove certain loss peculiarities promises a much needed, very compact, low power phase shifter for end-fire and side-looking antenna beam steering application for missiles and projectiles.

k. The Chemical Systems Laboratory evaluated commercial compounds as decontaminants. It was previously determined that one of the three more common riot control agents was soluble in a number of surfactant solutions and once dissolved would react with monoethanolamine. An investigation was started to provide an effective, easily mobilized, decontamination procedure for the three riot control agents. Several mixtures of detergents and cleaning additives, commonly available commercial products, have been tested for their ability to disperse, dissolve and chemically react with these agents. Practical decontaminants were uncovered for two of the three agents. The work will continue through FY 1979 to attempt to find a decontaminant for the third agent and to identify the nature of the reactions involved and the products produced by the decontaminants for the other two agents.

l. The Army Cold Regions Research and Engineering Laboratory modified a tensiometer for use under freezing conditions as one of their ILIR projects. Nearly all line-of-communication construction by the Army such as, airfields, roads, helipads, and embankments, whether permanent or expedient, continue to be adversely affected by freeze/thaw winter conditions. Inadequate knowledge concerning moisture migration in soil during freeze/thaw is a key deficiency that must be overcome if criteria and specifications are to be substantially improved. A very sensitive device for measuring moisture tensions in soil systems subjected to freezing and thawing has been developed. The device is ten times more sensitive than the most sensitive item available. With the addition of glycol the tensiometer can withstand repeated freeze/thaw cycles with no sensitivity loss. The developed system involves modification to a commercial device such that the tensions can be monitored electronically on a continuous basis. These devices will now permit reliable monitoring of moisture migration in laboratory and field settings.

m. The US Army Tank-Automotive Research and Development Command Laboratory applied holography to vehicle structure analysis. The task resulted in techniques for obtaining and analyzing the vibration patterns in vehicle components and structures. Particular emphasis was placed on the use of a long coherence length ruby laser to make double exposure holograms of components subjected to mechanically induced vibration. High quality holograms were obtained and related to areas of large stress and vibration amplitude. The use of holographic techniques allows the vehicle design engineer to visually and analytically assess the vibration and stress patterns in a vehicle structure. The technique can have major significance in placement of damping material or structure stiffeners. It can also be used in the development of finite element analyses by displaying vibration or stress displacement units in wavelength of light for concept evaluation.

n. The Harry Diamond Laboratory performed an analysis of pulsed microwave power capability of the relativistic reflex triode. An experiment was designed to measure the effect of cavities upon the microwave output of the reflex triode. A resonator was placed on the anode with unexpected results. The power out in X-band did not increase while the frequencies observed decreased. The applied magnetic field was varied across the anode-cathode gap decreasing from 4 kilogauss to zero field strength. The vertically polarized microwave output increased from 40 megawatts at 4 kilogauss to 1.2 gigawatts at 2.5 kilogauss and then decreased to .6 of a gigawatt at zero field strength with center frequencies varying between 8 and 9 gigahertz. At 4 kilogauss and 2.5 kilogauss, the radiation output was approximately 80% vertically polarized. Below 1.5 kilogauss the vertical and horizontal components of power were comparable. The data indicate that there is a complex interaction between magnetic field, gap impedance, and electron motion. Potential applications include, radar, radio frequency heating of fusion plasmas, auto-electron accelerators, planetary and satellite communications, and electronic warfare weapons.

o. Missile Research and Development Command previous research resulted in development of techniques for measuring frequency modulation sideband spectral structures at frequencies very close to the microwave carrier. These results led to the postulation that a vehicle sitting still with the engine running will induce a very small (modulation index less than 0.1 millimeter) frequency modulation side band upon a radio frequency carrier that can be detected by the techniques recently developed. A mathematical model was generated and verified by laboratory experiment. A test model was constructed and successfully demonstrated that frequency modulation displacements of less than 0.1 millimeter could be detected and provided a relatively strong signal. The possibility of detection and identification of ground vehicles and helicopters with small special purpose radars or by adding this technique to existing continuous wave radars is feasible. By using this method, extraction of targets from clutter could be greatly enhanced due to the possible difference in clutter characteristics in the frequency modulation domain versus the amplitude modulation domain.

p. The Walter Reed Army Institute of Research studied the Chemotherapy and Chemoprophylaxis of Leishmaniasis. With an increase in the number of cases of leishmaniasis occurring in US Army personnel, research efforts have been made to develop a prompt and reliable diagnostic procedure for confirmation of suspect cases. A technique combining the use of needle aspirates from suspect lesions and an insect cell culture media has proven five times more sensitive than the present recommended culture procedure. Plans have been initiated for clinical evaluation of leishmania skin test antigen for possible use in screening large numbers of personnel exposed to leishmania in training exercises. Skin tests will be useful in identifying infections prior to manifestation of clinical lesions.

q. Letterman Army Institute of Research conducted studies on biochemical adaptations and dietary interactions of exercise training. Despite exorbitant claims by various individuals or health food groups, comparatively few dietary modifications have been demonstrated to enhance physical performance in well-nourished individuals. One of the objectives of this work is to obtain information on the potential of dietary modifications to enhance physical performance. Diets that elevate muscle and liver glycogen stores have proven to be the most reliable method of prolonging work time to exhaustion. The time of delivery of these high carbohydrate diets is critical, making such diets impractical under combat conditions where activity bursts cannot be

Program Element: #6.11.01.A

DoD Mission Area: #110 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)

Budget Activity: #1 - Technology Base

predicted. The hypothesis being tested in this study is that diets designed to enhance the utilization of body fat depots or increase the conversion of noncarbohydrate precursors to carbohydrate will be beneficial to physical performance. It has already been determined that certain unsaturated fatty acids and odd-carbon chain length fatty acids that lessen the hypoglycemia in starvation do not have a similar gluconeogenic effect during exhaustive exercise. The mobilization, deamination, and oxidation of certain amino acids during exercise to determine the contribution of protein to energy generation has been investigated and analyses of the samples and data are in progress.

r. The Army Institute of Dental Research is conducting research on the application of the carbon dioxide laser to military dentistry. The studies have resulted in a new method of small dental instrument sterilization which is extremely rapid, cost effective and nondetrimental to instrument cutting edges. Surgical application of the carbon dioxide laser to oral tissues indicates that predictable tissue effects can be obtained with ease, precision, and speed. The carbon dioxide laser is immediately hemostatic, sterilizes wound edges and heals with minimal inflammation.

s. The Army Institute of Surgical Research is conducting noninvasive studies of postinjury hemodynamic changes using the echocardiogram. Echocardiographic indices of left ventricular function in burned patients provide no evidence of left ventricular failure as the etiologic factor responsible for post burn shock, hyperdynamic septic shock nor the hemodynamic consequences of continuous positive pressure ventilation in patients with acute respiratory failure. Echocardiographic measurements have permitted the more accurate definition of cardiovascular status in burn patients who develop sepsis and/or respiratory failure following resuscitation. Echocardiographic studies of patients receiving continuous positive pressure ventilation for the treatment of respiratory failure indicated that the depression of cardiac output often seen in such patients is due to a decrease in left ventricular end diastolic volume secondary to impaired cardiac filling and not a result of myocardial depression.

t. Mobility Equipment Research and Development Command research involved animal biosensors as sensory elements in explosives detectors. These investigations initially demonstrated unequivocally that laboratory rats can easily be conditioned to respond to the presence of trinitrotoluene (TNT) vapor in the ambient air. Continuing investigations of variations in the cortical electro-encephalogram (EEG) of these animals when trinitrotoluene vapor is present in the ambient air provides significant evidence that a shift occurs in the power spectral density of the electroencephalogram signals when, and only when, trinitrotoluene vapor is present as an olfactory stimulus. Achievement of automatic annunciation of the presence of explosive trace vapors may lead to the development of practical detection systems which have the detection capabilities of animals and the user utility of the more conventional instruments of physical science.



Program Element: #6.11.01.A

DoD Mission Area: #110 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)

Budget Activity: #1 - Technology Base

u. Aberdeen Proving Ground is working on the Improvement of Shock Measurements for Armored Vehicles. Data from tests have shown conclusively that the best acceleration measurements were obtained using piezoresistive accelerometers and filtering. The most meaningful interpretation of the data was obtained by finding the peak velocity change. Tests showed that piezoresistive accelerometers produce more consistent, believable records than piezoelectric accelerometers. Electronic filtering was also found to be superior to soft mounts as the mounts introduced a new undamped resonance not present in electronic filtering.

v. Natick Research and Development Command research studied a chemical approach towards predicting wholesomeness of irradiated meats. The approach involves determining the electrophoretic pattern of proteins extracted from precooked meats and comparing the effect irradiating the meats has on protein patterns. Results obtained indicate that the patterns for beef, ham, pork and chicken, except for a minor additional protein in the chicken, are the same. Irradiating to high doses leads to no significant change in patterns except for the amount of myosin extracted, decreasing with increasing dose. It can be predicted that a combined wholesomeness study on beef, pork, and ham would yield identical results for all and that wholesomeness data for chicken would be applicable to these meats. Significant savings could be realized and faster introduction of irradiated food would be possible by placing greater reliance on such chemical data. Additional research is underway to see whether the nutritional and functional properties of vegetable and cereal proteins can be significantly improved by a novel chemical process called plastein reaction. Preliminary results have shown an increase in the amount of the essential amino acids and has shed some light on the chemical structure of the plastein product. The contribution to the Army will probably be toward higher quality meat extenders and an increase in more nutritional vegetable protein.

w. The Fire Control and Small Caliber Weapon Systems Laboratory research in modeling scattering signatures is considered to be highly significant in terms of its application to fire control optics and to the characterization of engineering surfaces in weapon mechanisms. The relationships between surface electromagnetic scattering and the statistical parameters of surface topography were carefully reviewed and analyzed. The results are significant in that they deal with mechanical properties of surfaces and in particular challenge the present American National Standards Institute standard for stylus force, which ignores elastic deformation of surface. This omission can lead to significant errors in measurement.

x. The Atmospheric Sciences Laboratory studied meteorological satellite techniques for Army air operations. The objective was to determine the feasibility of accurate analysis of mesoscale surface conditions as they relate to Army air operations from the perspective of above the battle zone and at a great distance. The most important factor in making an accurate analysis of the raw satellite data is having the ability to view the same region at least as often as significant meteorological changes might occur. When comparing classification values of an analyzed scene in terms of the altitude of a cloud/fog mass from an area remotely located from the control with observations that were not used for determining central classification values, the results were always close. The results are encouraging and support the feasibility of meteorological satellite techniques for Army air operations. Indications are that only a few observations from well behind our lines would be necessary initially, with occasional observations made days apart simply to assure stability of the system.

Program Element: #6.11.01.A  
DoD Mission Area: #110 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)  
Budget Activity: #1 - Technology Base

2. FY 1979 Program: Based on the merits of the annual report submitted by each participating activity at the close of each fiscal year, new funding is allocated for the upcoming fiscal year. Directors of individual laboratories or comparable activities assign funds to both new and continuing promising work efforts. The freedom from a rigidly structured program and the resulting autonomy at activity level permit the Directors to effectively use their in-house laboratory independent research funds.
3. FY 1980 Planned Program: This highly successful program will continue with no change in the basic objectives previously outlined. Changes in emphasis will occur as new ideas and techniques are considered and in accordance with advances in the state-of-the-art. The funding proposed for FY 1980 will provide a modest increase for this innovative program.
4. FY 1981 Planned Program: The program will be continued with the same management policies and objectives.
5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>92283</b>	<b>100305</b>	<b>118680</b>	<b>140792</b>	<b>Continuing</b>	<b>Not Applicable</b>
AF22	Research in Vehicular Mobility	1257	430	750	1150	Continuing	Not Applicable
AN42	Research in Materials and Mechanics	2000	2100	2500	2750	Continuing	Not Applicable
AN43	*Research in Ballistics	5760	6486	7290	8050	Continuing	Not Applicable
AN44	Research in Fluidics, Nuclear Effects, and Ordnance Electronics	2922	2290	2835	3000	Continuing	Not Applicable
AN45	*Air Mobility Research	5025	5365	6000	6400	Continuing	Not Applicable
AN46	**Research in Combat Surveillance and Target Acquisition	0	200	400	600	Continuing	Not Applicable
AN47	Electronic Devices Research	2143	2000	2400	2650	Continuing	Not Applicable
AN48	Electromagnetic Propagation and Antenna Research	900	1220	1550	1800	Continuing	Not Applicable
AN49	Missile and High Energy Laser Research	1300	1680	2400	2900	Continuing	Not Applicable
AN51	Combat Support Research	750	800	1100	1300	Continuing	Not Applicable
AN52	Research in Support of Equipment for Individual Soldier	1715	1780	2015	2310	Continuing	Not Applicable
BH57	*Research in Scientific Problems with Military Applications	28081	31950	38646	50980	Continuing	Not Applicable
AN60	*Research in Large Caliber Armaments	4850	5160	5970	6500	Continuing	Not Applicable
AN61	Research in Small Caliber Armaments	1100	800	1240	1500	Continuing	Not Applicable



Program Element: #6.11.02.A  
DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences  
Budget Activity: #1 - Technology Base

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
AN63	Research in Electronic Warfare	100	100	300	450		Not Applicable
AN68	Processes in Pollution Abatement Technology	0	200	220	260	Continuing	Not Applicable
BS01	*Basic Research on Military Injury and Diseases	8770	10010	12172	14138	Continuing	Not Applicable
BS02	***Basic Mechanisms of Recovery from Injury	1282	802	2342	2877	Continuing	Not Applicable
BS03	Medical Defense Against Biological Agents	2223	3022	3173	3290	Continuing	Not Applicable
BS04	Identification and Health Effects of Military Pollutants	385	420	450	500	Continuing	Not Applicable
BS05	***Military Burn Research	1510	1690	775	0	Not Applicable	Not Applicable
BS06	Combat Dental Materials and Techniques	692	812	853	882	Continuing	Not Applicable
BS07	Helicopter, Combat Crew, and Airborne Medicine	343	380	399	417	Continuing	Not Applicable
BS08	Environmental Stress, Physical Fitness, and Medical Factors in Military Performance	1121	1925	2021	2222	Continuing	Not Applicable
AT22	Research in Soil and Rock Mechanics	341	425	575	605	Continuing	Not Applicable
AT23	Basic Research in Military Construction	274	510	560	650	Continuing	Not Applicable
AT24	Research in Snow, Ice, and Frozen Ground	1557	1425	1645	1725	Continuing	Not Applicable
A31B	**Night Vision and Electro-optics	5890	6100	6900	7500	Continuing	Not Applicable
B52C	Research in Geodetic, Geographic, and Mapping Sciences	1508	1362	1500	1600	Continuing	Not Applicable



Program Element: #6.11.02.A  
DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences  
Budget Activity: #1 - Technology Base

The actual FY 1978 funding reflects increased emphasis on combat vehicle research and blast overpressure research; the determination of baseline data on the performance capabilities of soldiers wearing Army chemical, biological and radiological protective equipment; and the transfer of management and support funds for the Army Research Office and the Aviation Research and Technology Laboratories (formerly included in the 6.5 category) from 6.5 to program element 6.11.02.A for comparability purposes. FY 1979 funding changes reflect the Congressional guidance not to initiate the proposed Defense Science and Engineering Program in FY 1979 at the \$3 million level, and the transfer of \$3,605 thousand from the 6.5 category to program element 6.11.02.A to pay management and support costs at the Army Research Office and Aviation Research and Technology Laboratories. The change in FY 1980 funding reflects overall RDT&E funding requirements and priorities, Congressional guidance concerning the support of contract research, the transfer of funding responsibility for management and support costs of the Army Research Office and Aviation Research and Technology Laboratories from the 6.5 category to program element 6.11.02.A, and a \$20 thousand reduction in administrative travel.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** This program supports research to establish technical expertise in the physical, engineering, environmental, biological-medical, and behavioral-social sciences directly related to Army needs and to the solution of identified Army problems. It provides the base for subsequent exploratory and advanced developments in Army related technologies and for new or improved military capabilities in: armor; new materials for armaments; weapons and munitions; electronics; communications; seekers; detectors; surveillance and tracking systems; propulsion and aerodynamics for missiles; energy conservation; energy conversion; environmental quality; construction and field fortifications; medical and biological sciences; food; clothing; soldier support; night, dirty battlefield, smoke, and foul weather operations; terrain characterization; vehicle mobility; navigation; and human-weapons integration. Research in the physical and engineering sciences is generally carried out in the laboratories of the US Army Materiel Development and Readiness Command and by contracts with industry, universities, and other Government agencies from these laboratories. Research on grants or contracts with the academic community, industry, and not-for-profit organizations, is administered by the Army Research Office, an agency of the US Army Materiel Development and Readiness Command. Research involving environmental sciences, military construction, and positioning is carried out in laboratories of the Corps of Engineers and at the Atmospheric Sciences Laboratory of the US Army Materiel Development and Readiness Command. Research in the medical-biological sciences is pursued in several laboratories under the US Army Medical Research and Development Command. Research in human behavior and human interaction with weapon systems is conducted at the Human Engineering Laboratory of the US Army Materiel Development and Readiness Command and at the US Army Research Institute for the Behavioral and Social Sciences.

**G. RELATED ACTIVITIES:** The Navy, Air Force, and other Department of Defense agencies; National Aeronautics and Space Administration; National Academy of Sciences/National Academy of Engineering/National Research Council; National Science Foundation; Department of Interior; Department of Energy; National Bureau of Standards; Department of Health, Education, and Welfare; other Government agencies; Government agencies of allied nations; and the industrial and academic community sponsor related research in some areas of this program. Coordination to eliminate duplication is accomplished by tri-service reviews; exchange of progress reports and technical reports; inter-service/agency liaison; and formal, national and international meetings and symposia. Informal coordination occurs through: visits to Governmental, industrial, and academic laboratories and installations; review of the scientific literature; and publications of current research. The Army's Defense Research Sciences Program is included in the Tri-Service Technology Coordinating Papers. Additional details on related activities are provided in individual project descriptive summaries.

**H. WORK PERFORMED BY:** The research supported under this program is performed by in-house laboratories and activities; and by academic institutions, not-for-profit organizations, and industrial laboratories through contracts and grants. Specific contractors are listed in the project and scientific area descriptive summaries. The laboratories/activities responsible for research under this program are the following, listed by major Army developing agencies:

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

US Army Materiel Development and Readiness Command:

Tank-Automotive Research and Development Command,  
Warren, Michigan  
Materials and Mechanics Research Center, Watertown,  
Massachusetts  
Ballistic Research Laboratory, Aberdeen Proving Ground,  
Maryland  
Harry Diamond Laboratories, Adelphi, Maryland  
Aviation Research and Technology Laboratories, Moffett Field,  
California  
Combat Surveillance and Target Acquisition Laboratory,  
Fort Monmouth, New Jersey  
Electronics Technology and Devices Laboratory,  
Fort Monmouth, New Jersey  
Communications Research and Development Command,  
Fort Monmouth, New Jersey  
Electronic Warfare Laboratory, Fort Monmouth, New Jersey  
Missile Research and Development Command, Redstone Arsenal,  
Alabama  
Mobility Equipment Research and Development Command,  
Fort Belvoir, Virginia  
Natick Research and Development Command, Natick, Massachusetts  
Large Caliber Weapon Systems Laboratory, Dover, New Jersey  
Benet Weapons Laboratory, Watervliet, New York  
Fire Control and Small Caliber Weapon Systems Laboratory, Dover,  
New Jersey  
Army Research Office, Research Triangle Park, North Carolina  
Night Vision and Electro-Optics Laboratories, Fort Belvoir,  
Virginia  
Atmospheric Sciences Laboratory, White Sands Missile Range,  
New Mexico  
Chemical Systems Laboratory, Aberdeen Proving Ground, Maryland  
Human Engineering Laboratory, Aberdeen Proving Ground, Maryland

Title: Defense Research Sciences  
Budget Activity: #1 - Technology Base

US Army Corps of Engineers:

Waterways Experiment Station, Vicksburg, Mississippi  
Construction Engineering Research Laboratory, Urbana, Illinois  
Cold Regions Research and Engineering Laboratory, Hanover,  
New Hampshire  
Engineer Topographic Laboratories, Fort Belvoir, Virginia

US Army Medical Research and Development Command:

Walter Reed Army Institute of Research, Washington, DC  
Letterman Army Institute of Research, Presidio of San Francisco,  
California  
Medical Research Institute of Infectious Diseases, Fort Detrick,  
Maryland  
Medical Bioengineering Research and Development Laboratory,  
Fort Detrick, Maryland  
Institute of Surgical Research, Fort Sam Houston, Texas  
Institute of Dental Research, Washington, DC  
Aeromedical Research Laboratory, Fort Rucker, Alabama  
Research Institute of Environmental Medicine, Natick,  
Massachusetts

Office of the Deputy Chief of Staff for Personnel:

US Army Research Institute for the Behavioral and Social  
Sciences, Arlington, Virginia

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Research to improve combat/tactical vehicle performance provided new holographic interferometry techniques to test tank-automotive components. Experiments with ultrasonic surface wave absorption/reflection resulted in a new method for crack detection. A capability was developed to analyze the dynamics of agile, lightweight tanks in straight paths and during sharp turns in soft soils. Materials and mechanics research produced procedures for manufacturing high quality tungsten for penetrator projectiles, new methods for analyzing shear and fracture properties under shock loading, and a new evaluation plan for antiblast plastic foam or metal plate. Accomplishments at Ballistic Research Laboratory include: new techniques to compute projectile aerodynamics; improved methods to measure plastic deformation of metals and extension of basic armor penetration theory; a better understanding of the propellant burning process on a molecule/molecular fragment scale; improved computer codes which predict tip velocities, jet shapes, and internal energy in shaped charge munitions; and target/penetrator interaction models which now include 3-dimensional effects. Air mobility research yielded advanced helicopter rotor blade designs, more accurate methods to measure 3-axis velocities using lasers, and completed measurements of energy absorption capabilities of composite materials leading to better rotor performance. Electronics research at Harry Diamond Laboratories in cooperation with Radio Corporation of America has explained the mechanism of charge transport in silicon-silicon oxide capacitors and explained behavior of these capacitors toward pulsed electron beams. Also, acousto-optic signal processing methods and devices have been discovered. These novel devices, called memory correlators, exhibit an 80 megahertz band width and 70 decibels of dynamic range with phase errors of less than five percent. Several have been built to exploit this method for signal storage and comparison of the incoming signal with the stored signal. Electronics Technology and Devices Laboratory scientists grew new high quality, semi-insulating gallium arsenide substrates for evaluation in microwave oscillators and amplifiers; single crystals over one inch in diameter will be useful for high speed logic circuitry. They also extended the pressure-oxidation (P-OX) method to grow significantly denser silicon oxide on silicon semiconductors and have discovered lithographic polymers which are more radiation sensitive. These several advances will lead to improved integrated circuit materials with vastly higher data processing capacity for a variety of applications. New concepts in communications antennas were developed to design smaller, less detectable, more efficient tapered dielectric rod antennas. Night Vision and Electro-Optics Laboratory research produced lasers operating with useful powers at near millimeter wavelengths for penetrating battlefield dusts, fog, and smoke. Detector efficiencies in the near infrared region were increased and the useful operating temperature of night vision detector elements was increased, eliminating the necessity of cryogenic coolants. A process for forming very high efficiency gallium arsenide charge transfer devices for far infrared high speed image processing and uncooled low light level imagers was discovered. Missile Command research produced new concepts in sensors, terminal homing guidance, and control and propulsion for future missile systems. Significant accomplishments include laser induced chemical preparation of a missile propellant related compound, decaborane; target acquisition techniques for missile guidance; and acquisition of near millimeter wavelength propagation data under different weather conditions. Swept-gain superradiance is a major achievement drawing wide acclaim. Researchers cause methyl fluoride gas to radiate coherent, intense, short pulses of light. This phenomenon gives the maximum intensity of light possible in accordance with the physical conservation laws. Research continues to produce improved power sources and generators for Army mobile units. Lightweight fibers of graphite have been intercalated (ions infused in the lattice structure) to yield stronger electrical



Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

conductors with conductivities higher than copper. Batteries and fuel cells to power instrumentation and other equipment have been improved by discovery of new electrode catalysts and acid electrolytes. Food research continues to yield rapid methods for evaluating the quality and nutrition of foods and to provide many advances in careful packaging and evaluating and preserving wholesomeness. Accomplishments from Army sponsored research programs in academic and not-for-profit institutions are reported in a separate descriptive summary for project BH57. Research in military injury and disease maintained a science base for assessment and prevention of virus disease casualties. A broadened scope of effort for drug research and a reorientation of this program for casualty care from hospitals to the field has been undertaken. Research to determine effects of high impulse noise was recently organized. Specific accomplishments are described in a separate descriptive summary for project BS01. Other medical research resulted in an improved liposome encapsulation concept for timed release of effective drug levels as a safer method of administering drugs. Concepts of burn therapy were formulated and tested. Activity in this area was at the forefront of medical research. Investigations of systems health hazards identified high frequency hearing loss associated with low frequency noise; identified a cellular level phenomenon connecting overt behavior and emotional state; and established a data base for determining laser and microwave human exposure standards. Combat injury research resulted in a rapid micromethod for field identification of wound pathogens and the investigation of a novel system for decontaminating field dental units. In Corps of Engineers' laboratories, soil and rock research led to a novel laboratory technique for soil testing by neutron analysis. Laboratory tests of industrial wastes as construction materials were completed. A reference manual was written on the characterization of fracture surfaces for engineering materials. This manual and a new procedure to evaluate energy technologies for military installation requirements will greatly aid future military construction design. Engineers/scientists at Cold Regions Research and Engineering Laboratory developed an improved understanding of the relationship between clay microstructure and the mechanical properties of frozen soil. They also prepared a standard set of terrain data for mobility and combat engineer use. Mapping, Geodetic, and Geographic research emphasizes acquiring, processing, storing, and displaying topographic data for tactical use. Recent accomplishments include the development and testing of radar reflectance and correlation models, acousto-optical procedures successfully used for image analysis, and favorable evaluation of gelatin emulsions for use in recording holograms. Atmospheric sciences research resulted in quantitative characterization of the atmospheric effects on laser beams, an upgraded smoke obscuration computer model, and completion of terrain effects and wind models for smoke dispersion. Smoke research at Chemical Systems Laboratory resulted in a better understanding of smokes and uses of smoke in the infrared region of the spectrum. The Human Engineering Laboratory established a scientific basis for evaluating soldier performance under adverse, combat-like conditions. Noise suppression methods were devised and a textbook was published relating eye movement and psychological combat performance. At Army Research Institute studies were completed to obtain basic knowledge and to improve the data base supporting Army personnel education, training and training devices, and training simulation in operation of complex Army systems. Experimental programs in leadership training, organizational processes in field settings, effect of a man's experience on his group performance, processes in tactical man-computer information transfer and analysis of movement factors in distance perception were completed.

2. FY 1979 Program: Research in vehicular mobility directed toward improved combat vehicle performance includes studies of the dynamics of high powered tracked vehicles and wheeled vehicle agility, and investigations of terrain sensors, suspension, terrain profile, and human tolerance to vehicle ride. Materials and mechanics research is conducted in structure and properties

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

of new and advanced materials to obtain more durable composites, to reduce gun tube erosion, and to prepare and test improved polymer systems for use as structure and armor materials. Shock analysis procedures and materials fracture properties are being validated and work on analysis of the response of laminated hulls to suspension loads and blast effects initiated. Research to advance the state-of-the-art in rotary wing aerodynamics, structures, and propulsion and in mathematical analysis and modeling in helicopter component performance is reported in a separate descriptive summary. Separate summaries are also provided to report large caliber armament and other ordnance research conducted at the Ballistic Research Laboratory (AR43) and the Large Caliber Weapon Systems Laboratory (AR60). Small Caliber Weapon Systems Laboratory generates innovative concepts for target location, identification and tracking and plans to look into the feasibility of control concepts for weapons stabilization. At Harry Diamond Laboratories research is conducted in fluidics control systems, sensors, amplifiers, and circuits analogous to electronic instrumentation which may provide alternative system components resistant to interference or damage from radiation. Research in dielectrics, heterodyne detection, and acousto-optical signal processing is underway to increase the technology base for military applications of these materials in surveillance and target acquisition electronics. The Electronics Technology and Devices Laboratory continues to transfer their original techniques of pressure oxidation (P-OX) to industry. Research for growing semi-insulating gallium arsenide and for promising materials and methods for printing microelectric circuitry is in progress. These important areas will lead to better military electronics equipment with greater speed and reliability and smaller size. Better lithium-thionyl batteries to power a variety of electronic devices are also under investigation. Communications oriented researchers intend to complete a study of efficiency to bandwidth trade-off for low profile antennas; establish a data base for high frequency band utilization in urban battle; start an evaluation of adaptive communication concepts; initiate a computer software effort to model the total electromagnetic environment during communications; and initiate a simulation model of a new large scale digital data distribution system. Fiber optical cable is so promising for rapid transmission of data, voice and video that a three-year effort was begun to improve the radiation resistance of experimental fiber optic communication cables. A research effort is on-going to develop modulation/coding methods to permit rapid signal acquisition in an energy jamming environment. Night vision and electrooptics research in thermal imaging and lasers for all-weather designation and tracking on the battlefield is described in a separate descriptive summary for project A31B. Missile and high energy laser research aims toward improved target cueing utilizing such concepts as solar induced luminance of target versus area background for missile guidance. Also, experiments to establish new specific laser induced photochemical methods to produce missile propellants are conducted. An area of emphasis is to acquire basic data on propagation of near millimeter waves through the atmosphere. Swept gain superradiance continues to be investigated with better pumping techniques. Research in electronic warfare explores new concepts for jammers, spoofers, interrogation, and threat warnings. Specific subjects now being studied include "quasi homogeneous" light sources in the infrared region and propagation of signal and jamming radiation past terrain obstacles. Several projects in combat support go into specific problem areas in mobility and survivability. Land mine responses to mine-clearing blast caused by fuel-air explosives are being modeled. Research in fuel cells may result in improved power sources as a consequence of new work with trifluoromethane-sulfonic acid electrolytes and studies of new reactions of hydrocarbons on fuel cell electrodes. Sturdier electrical conductors made by graphite fiber intercalation (infusion of charged ions) will be designed which conduct electricity better than copper and at about one third of the weight of copper. Research to provide nutrition guidance, food storage concepts, food acceptance standards, concepts of protection from microbial degradation, clothing protection and camouflage continues at the Natick



Program Element: #6.11.02.A  
BoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences  
Budget Activity: #1 - Technology Base

Laboratories. Specific FY 1979 efforts include: critical food/ration modelling to optimize field food and nutrition; exploration of food degrading effects of enzymes; development of automation to assess food intake; and optimization of clothing and eye protection against nuclear and laser radiation. Research in military diseases and injury are reported in a separate descriptive summary for project BS01. During FY 1979, specific anticipated accomplishments by the Army Medical Research and Development Command's laboratories are: extension of the science base in drug development, blood preservation and burn treatment while developing new concepts for combat casualty management; demonstration of the feasibility of using purified microbial products and new additives to increase vaccine efficiency; development and evaluation of concepts explaining the transmission of hepatitis; testing of new diagnostic methods for virulence and antigenicity; characterization of hearing loss associated with genetic and molecular properties responsible for excessive alcohol and drug use; identification of the processes of low frequency noise; definition of medical aspects of excessive alcohol and drug use; identification of the effects of oral laser induced eye injury; establishment of a model to interpret effects of impulse noise; evaluation of the effects of oral tissue microorganisms in possible future combat areas; studies of nerve gas effects; studies of control of pain and anxiety by drugs; evaluation of the effects of maxillofacial disease or trauma; development of immuno-fluorescence techniques for the diagnosis of arboviruses; and evaluation of new insect repellants in the field. Engineering laboratories are continuing research in properties and response of earth and construction materials and finished structures to munitions impacts and explosions, and responses of earth and soils to high speed operations of vehicles. The frictional effects of soil-structure interfaces are being tested in the laboratory. Field tests are conducted on cased and uncased munitions to measure effects and to validate a model for predicting steady-state steering of tracked vehicles. Research in military construction and materials continues. Specific accomplishments expected in this area are: a completion of a study on the utilization of waste for construction; completion of simplified models to predict building energy use based on weather statistics; completion of specifications for an integrated computer-aided engineering and architectural design system data base; and definition of the data-structure requirements for a construction materials data base. Scientists and engineers at the Cold Regions Research and Engineering Laboratory utilize scanning electron microscopy to determine the microstructure of accrued ice; incorporate field data acquired last year into designs for roads in permafrost areas; and determine needs for atmospheric data in the arctic regions. Engineer Topographic Laboratory continues to develop optimal techniques for post-mission adjustment of terrain reconnaissance data; provide for more automated extraction of terrain features; and make initial definition of terrain feature classification schemes used in photo interpretation. The Atmospheric Sciences Laboratory on-going research continues to provide data, descriptions, and in-depth understanding of atmospheric behavior which affects battlefield operations. They are improving their computer models to describe light transmission through smoke, fog, snow, rain, and battlefield gases and dusts. Criteria for the design of long range remote wind sensors for artillery are being defined. Human Engineering Laboratory continues to search for new ways of displaying visual information utilizing peripheral vision. A revised damage/risk criterion is being developed to prevent hearing loss. A first textbook on pictorial processing will soon be published. Scientists at Army Research Institute for the Behavioral and Social Sciences support Army personnel and manpower activities, Army training and education, and training device and training simulation activities, and human factors in Army operations. Projected accomplishments for this year include completion of a model for projecting a military manpower base for more efficient use of personnel and manpower resources.



Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

3. FY 1980 Planned Program: Improved combat vehicle performance will be achieved through investigations of wheeled vehicle agility, human tolerance, and vehicle/weapon stability and response. Adaptive suspension research will be completed. A search for new ways to suppress tank signatures to avoid enemy detection will continue. Research in and exploitation of advanced materials for Army structures will include composites which resist moisture degradation; a determination of the mechanical properties of superelastic alloys; and improvement of the data base and computer simulation codes to predict shock/materials fracture. Fundamental scientific and engineering research in armaments and ordnance will provide supporting information for development efforts to demonstrate the travelling charge concept for hypervelocity launch. Predictive computer models will be refined for anticipated launch and flight problems, improved material properties, explosives initiation and propagation, armor and armor penetrators, interior ballistics and fracture dynamics. This extensive and incisive research will lead to a more complete understanding of penetrator/explosive efforts and better design of projectile and warhead ballistics. Promising novel thermally stable explosives will be investigated and criteria for propellant/igniter characterization will be optimized. Specific areas of research emphasis in large and small caliber weapons will continue to be modelling of ignition and combustion phenomena in gun propellants, reduction of large bore barrel wear and erosion and modelling of armor and armor penetration. Fire control related research will evolve methods for automatic control of coupling of the component weapon to fire control and load phenomena. Fire control related research projects will involve studies of atmospheric properties, microelectronics, night vision, control automation, and computer technology, lasers and electrooptics, sensing/detection and signal processing, computational methods, and large scale systems modelling. Electronics for intelligence and target acquisition will concentrate on nuclear radiation damage on integrated circuitry and attempts to integrate optics in optical augmentation devices. Work in near millimeter wave sources will be extended to several atmospheric windows and speckle noise will be characterized. Fluidic sensor research will continue. Novel techniques for preparation of the basic materials for integrated circuits will continue at the Electronics Technology and Devices Laboratory. Gallium arsenide (GaAs) oxidation will be more reliably done by the pressure oxidation method with less chance for defects. Proton enhanced diffusion of controlled impurities into gallium arsenide will be investigated. Continued electron beam resist research and lithography using these resists, molecular beam epitaxy, and ion-implantation for large scale integrated circuit applications promise better integrated circuit materials for a variety of seekers, sensors, communications, and electronic warfare equipment. Improvements will be made in rechargeable lithium batteries to power communications equipment. An analysis will be made to clarify lithium/sulfuryl chloride battery cathode kinetics. Millimeter and microwave propagation through foliage, high frequency/very high frequency antenna tuning, matching, and directivity control, radio wave propagation and signal losses in built-up areas (cities) and scintillation will be studied to develop new concepts and provide solutions to problems in tactical communications. The Combat Surveillance and Target Acquisition Laboratory will initiate new programs in antenna patterns over wide bandwidths and wide azimuth angles to achieve deeper nulls utilizing frequency and time dispersive functions. Simulation of pattern behavior and signal recognition in a high jamming environment will be areas of prime concern. Research in night vision and electrooptical devices is reported in a separate descriptive summary. Important accomplishments projected in this program include studies of active/passive infrared focal planes for heterodyne imaging and tracking and a complete study of acoustic signatures for battlefield target cueing. Research at the Missile Research and Development Command will extend initial efforts in laser induced catalysis to produce missile propellant formulations, missile seeker window materials, evaluation of a new induced dipole laser concept, and evaluation of the interaction of submillimeter radiation with smoke and natural obscurants. Mobility Equipment Command Laboratories will continue research

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

in mobility, survivability, and service support by investigating new enzymes to detect military explosives other than trinitrotoluene (TNT) and fuel cell concepts of adsorption and oxidation on new electrode catalysts; and by modelling responses of nuclear hardened mines to mine clearing explosives. Natick Laboratories will study the nutritional effects of higher sugars such as sorbitol and manitol, develop and apply rapid assay methods for food microbiological problems, study the basic effects of taste/smell mixtures, and elucidate the mechanisms of enzyme inductions. In order to provide fundamental data on pertinent properties of earth and construction and engineering materials, Corps of Engineers' laboratories will conduct field tests of downhole geophysical methods for defining deep foundation conditions, develop computer models for analysis of pre-cast pavement units, compare effects of cased and uncased air-to-surface explosives, and develop computer models to predict nonsteady steering in tracked vehicles and to describe the soil-track interface. Military construction process modelling techniques will be transformed to a formal procedure simulation model. Engineers will demonstrate the applicability of the building energy analysis model. In the cold regions we need fundamental data on properties of snow, ice, frozen ground, and their related interactions with operational requirements and construction. Structure/mechanical properties of simulated snow cover layering will continue. The nomenclature of groups of soils will be determined in order to investigate the effects of composition on frozen vs unfrozen earth properties. Research in mapping, geodetic and geographic science will develop optimal methods to use the rapid geodetic survey system by incorporating previous knowledge of the gravity field; assess the value of optical mass memory storage of mapping data, and complete the review report on this subject; examine photoresist materials in order to explore the use of holography for storing mapping data; develop a concept for using image spectrum analyzers for extracting map features; and evaluate acousto-optical waveguide spectrum analyzers for automated extraction of terrain features. Scientists at the Atmospheric Sciences Laboratory intend to validate a radiative transmission model for dirty battlefield conditions and construct a mid-east battlefield dust model. Water vapor continuum measurements in the 8-12 micron infrared spectrum will be completed. Analysis of data gathered during the 1979 solar eclipse will be completed and new transport and diffusion models for battlefield aerosols will be derived. Research in military injury and disease is reported in a separate descriptive summary. Medical Research and Development will provide the necessary science base in biophysics and biomedicine to reduce casualties, minimize injury effects, maintain performance levels, shorten recovery periods and generate information on recovery from injury. Efforts for FY 1980 will include a demonstration of the applicability of the drug science base to the selection of safe, effective classes of drugs for further development, test and evaluation, and expansion of the data base to new candidate classes. Medical scientists will also organize the known data on combat casualties into an effort to gather knowledge and operational methods to handle blood preservation, shock trauma, and burn injury and establish data to understand medical effects of chemical agents, their mechanisms of action and best methods of counteracting them. Research efforts to understand and prevent health hazards from weapon systems will include: studies of low frequency vibration in military vehicles; design of a simulation model for the study of translocation; determination of chemical and smoke toxicity in a combat environment; investigation of microwave energy absorption and effects on animal tissue; exposure thresholds for high impulse noise and establishment of criteria for evaluation of human eye/machine interaction when using electro-optical displays and devices. Continuation of studies for the prevention, control, and treatment of disease, pain and injury in the maxillofacial and oral areas through new drug research is planned. At the Human Engineering Laboratory experiments will be conducted to determine baseline data for soldiers operating various equipment while wearing chemical-biological-radiological protective gear. Psychological stress effects research utilizing a unique new evaluation method will be conducted and a model



Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

will be developed on sound detection and identification. The results of leadership research on decision making during organizational crises will enhance understanding of the process under stress and contribute to developing sharper training techniques for potential leaders. Job design and organizational effectiveness research will continue. The development of performance oriented education, individualized training and evaluation techniques and concepts, and the technology base for improved training devices and training simulation will continue. This program element supports 1700 in-house personnel (950 professional and 750 support personnel).

4. FY 1981 Planned Program: Holographic techniques will be applied to analyzing structural vibrations in tanks and dynamic turret/weapon station interaction will be analyzed for fire-on-the-move-effectiveness. Air Mobility researchers plan to investigate rotor shape vs aerodynamics, engine and drive train components, and to extend their efforts in fatigue tests of composites and technical risk assessment. Research in materials and mechanics will concentrate on reduction of gun tube wear and erosion and analysis of shock, materials fracture and fatigue crack growth. Ballistics research will continue to provide information leading to improvements in small and large caliber weaponry by modeling launch and flight behavior, shaped charge jet formation, penetration damage, and other ballistic events for direct fire weapons. Large Caliber Weapon Systems Laboratory will investigate gate factors influencing ignition and propagation of propellant and explosive reaction fronts and factors to control them. They will develop a dynamic model for fracture of penetrators. Fire control research will extend to signal processing and control and stabilization concepts to attain all-weather operation and fire-on-the-move capability. Research in electronics and electrooptical phenomena such as heterodyne detection, acoustic-optical memory devices, near-millimeter wave propagation and detection, new solid-state substrates for faster and higher data rate integrated circuits, fiber optics, near-millimeter and radar waveguide concepts, new electronic warfare ultraviolet detectors, detectors for nuclear radiation, high bandwidth suppression and antenna technology using frequency and time dispersive functions will be conducted at several Electronics Command laboratories to enhance our capabilities, communications and on-board data processing for better fusing, target acquisition, and projectile guidance. Night vision and electrooptics research will look for better ways to acquire and track targets through clouds, smoke and battlefield dust, through research and development of focal plane multidetector arrays for passive/active laser radar, and the development of 10,000 to 1 compression of tactical imagery. Tactical target signature modeling will be completed for the visible and infrared spectral regions and validated against weather extremes. Feasibility for electrooptical extraction of sonic signatures for target location or identification will be demonstrated. Future work will also include microintegration of laser sources and electrooptical elements, and studies of properties of adaptive optics for tactical laser devices and systems. Antenna research will support millimeter wave development efforts; continue theoretical and experimental investigations of low profile high frequency/very high frequency antennas; and extend to solving problems of communications in built up areas. Transionospheric studies to be conducted during the passage of the sun through its next activity peak during late 1980 will be completed. Electronic Warfare labs will study applications of sparse antenna arrays to signal wave front analysis and investigate adaptive techniques for spectral deconvolution. Research in optical fiber communications in military and nuclear environments will be completed. Missile-related research includes: target recognition techniques; laser photochemistry for propellant synthesis; swept gain superradiance in shorter wavelength regions; and demonstration of operational features of gradient index optics in guidance and control links. Efforts to improve techniques for mine detection and fuel air explosives for mine clearing and to improve troop supporting electrical generators and lightweight conductors will continue. Troop support research in feeding, nutrition, and packaging of food will be extended through



Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

studies of microbial and biochemical control mechanisms and environmental and sociopsychological factors in human food habits. Corps of Engineers' laboratories plan to continue and extend research in soil and rock mechanics pertaining to methods of defining building foundation conditions, soil stress decay, soil interaction with tank tracks, and effects of exploding munitions. Other projected work in military construction includes livability modeling and computer aided methods for optimum selection of resources by the facility engineer. Cold Regions Research and Engineering Laboratory will evaluate new data on effects of pressure on the strength of frozen soil and document their evaluations of terrain sensitivity to disturbance from pressure and other sources. The rapid geodetic survey system will be tested at the Engineer Topographic Laboratory in conjunction with a gravity gradiometer to gain highly precise measurements of terrain gradients. Atmospheric Sciences Laboratory will complete theoretical investigations of electrooptical sensor atmospheric effects and compilation of a library for the Middle-East; investigate high energy laser propagation forecast techniques and extend computer codes for elucidating upper atmosphere chemistry and physics which impact weather conditions. Chemical Systems Laboratory's projected accomplishments include evaluation of lidar for remote detection and rapid bioalarm systems; diagnosis and protection against effects of biological agents; and completion of size distribution evaluation of phosphorous and fog-oil type smokes dispersed under laboratory and tactical conditions. Medical Research and Development Laboratory will maintain existing science bases with internal adjustments as necessary to address new health threats or to exploit major scientific advances. Studies will continue on maxillofacial wound analysis, oral tissue effects of microorganisms, and field and combat physiological and psychological effects. At Human Engineering Laboratory, new sound absorbing materials and designs will be evaluated to reduce noise in crew areas of combat vehicles. Studies of the neural processing capacities of sensory pathways for augmenting crew performance and will test and report theories for individual performance and unit effectiveness. Laboratory experiments on group processes in units and a report on Junior Officer retention research should be completed. A vigorous extramural program to support basic and applied research in mathematics, electronics, mechanics, aeronautics, metallurgy, materials, physics chemistry, biology, and geophysical sciences of Army-wide interest will be pursued.

5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #AH43

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Research in Ballistics

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

**A. DETAILED BACKGROUND AND DESCRIPTION:** The objective of this research program is to advance the scientific areas of propulsion dynamics, launch and flight dynamics, warhead dynamics and mechanics, blast and kinetic energy projectile mechanisms and effects, ballistic protection, mathematical analyses, systems statistics, and decision theory. Major areas of emphasis in this program are devoted to the understanding of the processes involved in the operation of a weapon system such as the mechanics involved in gun barrel wear and erosion; the chemical kinetics under conditions of high temperatures and pressures in explosives and propellants; fluid dynamics and heat transfer involved in combustion, detonation, and incendiary processes; aerodynamics of projectiles, rockets, and missiles; and continuum mechanics controlling the interaction between explosives and metal. This research is a continuing integrated effort to provide the fundamental scientific and engineering base necessary to advance the myriad of weapon technologies. This effort is relevant to the entire spectrum of weapon systems ranging from small arms to large projectiles, missiles, and warheads.

**B. RELATED ACTIVITIES:** This research is related to efforts performed by the Navy, Air Force and the National Aeronautics and Space Administration. Coordination is accomplished by program reviews, exchange of program data sheets, research and technology resumes, technical reports, and liaison and attendance at scientific meetings and conferences. At the Office of the Secretary of Defense level, coordination is achieved through program reviews sponsored annually by the Office of the Under Secretary of Defense for Research and Engineering. Broader multinational coordination is achieved through joint participation of Australia, Canada, United Kingdom and the United States in the Technical Cooperation Program, and participation in the North Atlantic Treaty Organization Advisory Group on Aerospace Research and Development. Data exchange agreements exist on various aspects of ballistics research with the Federal Republic of Germany, France, and the United Kingdom. This project is planned and executed in close coordination with all laboratories in the Army Armament Research and Development Command, which includes the following 6.11.02.A research projects and titles: AH60, Research in Large Caliber Armaments; AH61, Research in Small Caliber Armaments; and A71A, Research in Defensive Systems for Chemical Warfare/Biological Warfare. The project is also closely coordinated with project AH80, Ballistics Technology in program element 6.26.18.A and with portions of the Army Research Office program supported under project BH57, Research in Scientific Problems with Military Applications in program element 6.11.02.A.

**C. WORK PERFORMED BY:** This project is performed or managed by the Ballistic Research Laboratory, Aberdeen Proving Ground, MD. The in-house effort is augmented through contracts with universities, industry and other government agencies. Principal contractors are Scientific Research Associates, Glastonberry, CT; Lyma-East, Wayneswood, PA; Lawrence Livermore Laboratory, Livermore, CA; Calspan Corporation, Buffalo, NY; and Johns Hopkins University, Baltimore, MD. Fifteen additional contractors will receive approximately \$500,000. Direct support to Research in Ballistics is also rendered through the Army Research Office under project BH57, Research in Scientific Problems with Military Applications.

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Project: #AH43

Program Element: #6.11.02.A

Bob Mission Area: #110 - Defense Research

Title: Research in Ballistics

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

1. FY 1978 and Prior Accomplishments: Experiments conducted with consolidated charges indicate they are essentially impermeable to gas flow and that their burn rates can be predicted. A lumped parameter equilibrium model, the first liquid propellant gun (LPG) analytical capability at Ballistic Research Laboratory (BRL), has been developed which simulates primer venting and early pressure rise. The goal of firing a bulk loaded LPG was achieved with significantly reduced heat transfer measured. A chemical process model was developed that predicts pressure and temperature dependence, predicts role of selected additive and aids in formulating improved propellants. An analytic model was completed for predicting the pressures on muzzle device components. The close in blast signature was discovered to be significantly altered by shock reflections. Successfully tested an aerodynamic code for ring airfoils at subsonic speeds, and no angle of attack. A basic sensor and telemetry unit was developed for inflight transmission of data on internal fluid payload pressures, fuze vibration environments and projectile spin. Results of non-shock initiation of explosives research indicate that a liner between the metal parts and the explosive may reduce munition vulnerability as ignition in heavily confined charges occurs as a result of casing failure and the extrusion of explosive into cracks in the casing. Techniques to measure strains in long rods during penetration have been developed for impacts up to 1200 meters per second. Volumetric strains during quasi-static plastic deformation have been carefully measured implying that for kinetic energy penetration there is a strong likelihood of coupling between pressure and distortion. The first multiphoton excitation in an atmospheric flame was carried out and used to deduce quenching rates and energy transfer rates in a flame.
2. FY 1979 Program: Characterize combustion of consolidated, conventional and superhigh burning rate propellants in support of the traveling charge concept for achieving hypervelocity projectile launch. Develop models describing the launch blast environment of gun systems; Magnus computational model; and composite model of correlated gun signature (acoustic/electromagnetic). Incorporate material strength and spin parameters in the applicable computer code. Apply new penetration theory to existing data for analysis. Gather data to permit quantitative characterizations of munition vulnerability. Extend target interaction models to include quantitative 3-dimensional effects. Quantify the phenomena underlying the interaction between a kinetic energy penetrator and armor. Develop the theory for electromagnetic signals observed when a projectile leaves a gun barrel and creates a transient magnetic disturbance and provide a comprehensive analysis of electromagnetic propulsion concepts. Characterize the internal flow in gun tubes a few calibers down-bore and complete benchmark calculations to select the hydrocode for computational efforts in penetration mechanics modeling. Continue the study of sampling techniques and experimental designs to improve procedures for ballistic firings providing improved statistical designs for indirect fire weapons for researchers.
3. FY 1980 Planned Program: For hypervelocity gun propulsion, the objective will be to provide basic experimental data in support of demonstrating the potential for hypervelocity launch through the traveling charge concept by selection of propellant and charge configuration through parametric combustion characterization studies. Improve mathematical modeling capability for anticipating launch and flight problems and for more effective testing in critical areas not yet amenable to theoretical predictors. Improve the material properties models through development of quantitative expressions for functional dependence of



Project: #AII43

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Research in Ballistics

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

pertinent parameters in explosive initiation mechanisms. Provide modeling for the establishment of the terminal effectiveness for future weapon systems and for the defeat of the associated armor threats by kinetic energy type weapons. Establish the terminal ballistic behavior of basic threat armor materials to high velocity defeat and develop the methods, models and experiments to quantify that defeat. Correlate electromagnetic wave gun signatures with other observables and construct a full-scale model of the cavity structure for the high-gradient accelerator capable of providing a local deep x-radiography capability. Continue to upgrade capabilities in multidimensional, multiphase, interior ballistics, penetration mechanics and fracture dynamics. This project will support 114 in-house personnel (59 professional personnel and 55 support personnel).

4. FY 1981 Planned Program: Develop improved structural integrity of the traveling charge concept and adjustment of propellant burning rates. Further test concepts for achieving high impetus with low flame temperature propellants. Expect to make considerable progress in accurately modeling the launch and flight behavior of special purpose ammunition and the weapon signature of particle gun/projectile systems. Develop well-defined analytical models for shaped charge jet formation and target penetration and complete evaluation of multi-component explosives for shaped charge warhead applications. Develop precise models of battle damage for incorporation into structural response codes. Incorporate blast load calculations of non-ideal shock wave phenomena and precise modeling of shock wave interactions with target boundaries into two and three dimensional simulation codes. Assess the potential use of coherent millimeter waves to recognize targets in clutter. Apply x-ray diagnostics to investigate surface and bulk properties of broad-band obscurant particles. Develop physical, mathematical and computational models of ballistic events. Develop a library of computer software for probability and statistics and develop experimental designs for direct-fire weapons.

5. Program to Completion: This is a continuing program.

6. Major Milestones: Not Applicable.

7. Resources (\$ in thousands):

	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	5760	6486	7290	8050	Continuing	Not Applicable
Funds (as shown in FY 1979 submission)	5760	6486	7050	-	Continuing	Not Applicable

The increase of \$240 thousand in FY 1980 will provide greater emphasis on determining the effects of nonmetallic rotating bands and modeling the mechanisms of wear and erosion.

FY 1980 ROUTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #AII45

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Air Mobility Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

A. DETAILED BACKGROUND AND DESCRIPTION: This project supports research to advance the state-of-the-art in rotary-wing aerodynamics, structures, propulsion, and mathematical models. The objective is to expand the technologies in those areas which are most likely to produce improvements in operational effectiveness, safety, survivability and life cycle costs of Army aircraft. Aerodynamics research is oriented toward advanced airfoils and rotors and addresses basic fluid mechanics, acoustics, dynamics, control and flight simulation. Structures research is oriented toward advanced materials and structural concepts such as advanced metal and composite aircraft components. Fatigue and fracture characteristics of these materials are being investigated and fracture control procedures and techniques are being developed. Propulsion research is directed at small engine technology to improve the internal aerodynamics of compressors, combustors, and turbines, and to increase turbine operating temperatures. Mathematical modeling research is developing mathematical techniques applicable to problems associated with air mobility research.

B. RELATED ACTIVITIES: This project supports the Army's aeronautical research program conducted in joint participation with the National Aeronautics and Space Administration (NASA) in accordance with the agreement between NASA and the Army. Related research is performed by the Navy, Air Force, Department of Transportation, and Department of Energy. Coordination to eliminate undesirable duplication within the Department of Defense is accomplished by program and topical reviews; through the exchange of program data sheets, research and technology resumes, and technical reports; and by inter-service liaison and visits. Broader coordination, including international coordination and cooperation, is accomplished by participation in the Quadripartite Standardization Program, The Technical Cooperation Program, NASA Research and Technology Committees, and the North Atlantic Treaty Organization Advisory Group on Aerospace Research and Development. The program supported under this project is closely related to, and planned in conjunction with, the scientific program of contracts and grants with industry and academic institutions that is implemented by the Army Research Office under project BH57, Research in Scientific Problems with Military Applications, and the technology program supported under element 6.22.09.A, Aeronautical Technology.

C. WORK PERFORMED BY: This work is performed by the Research and Technology Laboratories of the US Army Aviation Research and Development Command. The laboratories involved are located at Moffett Field, CA; Cleveland, OH; and Langley, VA. Much of this work is performed jointly with NASA Research Centers at these locations. The top 5 known contractors for FY 1980 are ADVEX, Newport News, VA; Martin-Marietta Aerospace, Baltimore, MD; Material Science Corporation, Blue Bell, PA; Spectron Development Laboratories, Mountain View, CA; and Dynamic Engineering Inc., Newport News, VA. The remaining contract program involves twenty-three contractors for a total of approximately \$1,550,000.

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Project: #AH45

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Air Mobility Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

1. FY 1978 and Prior Accomplishments: Analytically, the aerodynamic operating conditions for airfoils as a function of span and mission segment were defined for rigid blades. The source of the large vibratory loads on the retreating blade was traced to dynamic stall, while the factors influencing dynamic stall were traced to the blade upper surface turbulent boundary layer rather than the leading-edge-bubble bursting as originally hypothesized. Transonic numerical codes were developed to provide two-dimensional unsteady lifting blade load calculations and were extended to include three-dimensional non-lifting transonic calculations. These codes were checked with experimental data. Application of the design criteria for steady state flight with rigid rotors led to the design of an advanced rotor blade using three advanced airfoil sections. Four industry and three advanced airfoils were tested at high and low Reynolds numbers, and tests for dynamic stall characteristics of eight current generation airfoils were initiated to obtain a consistent data base for industry. The three axis laser velocimeter for the 7x10 feet wind tunnel is operational and has been used in tests of several rotor tip planforms. The in-flight acoustic measurement technique was utilized for the Source Selection Evaluation Boards on both the Utility Tactical Transport Aircraft System (formerly UTTAS, now BLACK HAWK) and Advanced Attack Helicopter (AAH). The data have improved the ability to analytically model rotor aerodynamic noise. The research to improve the toughness of high-temperature ceramics for turbine engine components resulted in selecting the system of reaction sintered silicon nitride surface layers on a more dense silicon nitride base to be the most practical system for potential use. The objective is to fabricate complex turbine blades and complete radial inflow turbine wheels at reduced costs. Fatigue analysis of composite repair patches on cracked metal components were completed and verified and a series of tests indicated that composite materials have a relatively low energy absorption capability. The presence of feedback or functional loops in the design of mechanical or electrical equipment can often make trouble shooting and diagnosis of malfunctioning hardware a challenging, if not impossible, task without replacing the entire piece of equipment. A theorem established during FY 1976 concerning optimal fault detection technique for loop-free systems has been extended to cover physical systems containing functional loops. A three-dimensional steady alternating direction implicit code to predict the flow on a hovering blade and a two-dimensional unsteady variant have been developed.

2. FY 1979 Program: Two-dimensional tests of a new family of airfoils for use on the AAH or BLACK HAWK is being conducted in the 6x28 feet wind tunnel. Testing of eight current generation airfoils in the 7x10 feet wind tunnel is being completed. Fabrication of the laser-diode system for the transonic-dynamics tunnel is being completed. Research is being conducted to extend the flap-lag air resonance analysis of the coupled rotor/body experiments to include a more accurate description of the blade and fuselage characteristics and include forward flight effects. Noise testing of the ogee tip (a rotor tip designed to reduce the acoustic signature) on the COBRA helicopter is being completed. Efforts to solve theoretical problems in high impulsive noise is continuing and the Hover Test Facility (anechoic chamber) is being used to verify theory on improved reduced noise rotors. Experiments are being conducted to define better rotor and rotor/fuselage flow fields with particular attention to rotor wake and down loading on various fuselage shapes. Efforts to obtain high strength silicon nitride based materials by sintering and using additives to enhance solid state diffusion is continuing. Two compositions of silicon nitride will be selected for further investigation; one suitable for high-temperature application such as turbine nozzle vanes and one for high-strength,



Project: #A1165

Program Element: #6.11.02.A

DD Mission Area: #110 - Defense Research

Title: Air Mobility Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

moderate temperature application such as bearing components. Research is beginning on low-cost techniques for sintering complex shapes. Research on fiber retention of polyimide-graphite composites in a combustive environment is continuing. In the area of compressor design, new models of the three-dimensional viscous flow analysis program is being used to design an improved centrifugal impeller. The Joint Army-National Aeronautics and Space Administration program to investigate fuel injector density and various injector types in a small, reverse-flow, annular combustor will be completed and results reported. Development of micro-processors capable of performing finite element analysis on small structural problems at extremely high speeds is continuing. Structural fatigue analysis is concentrating on prediction of stiffness and residual strength in unnotched isotropic laminates and outdoor fatigue testing to generate wearout data on their mechanical property retention under realistic environmental conditions is beginning. Static testing of a complete transmission support structure (low cost composite fuselage program) is being completed. Experiments to test the energy absorption of a series of specimens, aimed at investigating different composite fuselage fabrication concepts, is being conducted using riveted aluminum construction as the baseline. An investigation is being conducted to determine an efficient computational technique for identifying the optimal fault-isolation strategy. Work is continuing to extend the application of the three-dimensional steady alternating direction implicit code to the three-dimensional, rotor wake induced unsteadiness problem.

3. FY 1980 Planned Program: Advanced airfoils will be designed and tested both in two-dimensional and three-dimensional experiments. Rotor blade experiments to combine transonic and dynamic stall phenomena in one test will be conducted. Coupled rotor/body experiments and analysis will continue. Evaluation of concepts and devices for vibration reduction will be initiated. Extension of the flap-lag air resonance analysis will continue. An advanced "quiet" rotor blade will be designed and fabrication of a model will be initiated. The Hover Test Facility will continue to provide data on improved reduced noise rotors. Research will continue on the advanced design of compressors. A final report on sintered silicon nitride compounds will provide the technology base for exploratory development of ceramic components for advanced Army aviation application. The background obtained on laser velocimetry in centrifugal compressors will be applied to the problems of accurately predicting cooling requirements in radial flow turbines. The laser velocimeter will be used to map the internal flow characteristics in an advanced radial turbine. Effort will continue in the use of small prototype computers and the development of a software simulator for a much larger version of this device in order to anticipate scale-up problems and possible bottlenecks in the fabrication of complex structures. The environmental fatigue testing of composites and attempts to extend the previous analytical work to a broader class of composite laminates will continue. The low cost composite fuselage program will change its emphasis to look for more cost effective design/material/fabrication concepts for heavy frame elements. Crash energy absorption tests will continue. In computational fluid dynamics effort will be devoted to produce a working prototype of a small disturbance alternating direction implicit code to predict the unsteady, three-dimensional, transonic flow on a helicopter rotor of arbitrary planform. Efforts to apply the theory of fuzzy sets to risk analysis and work on the optimal fault-isolation strategy will continue. This project will support 143 in-house personnel (75 professional personnel and 68 support personnel).

Project: #A145

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Air Mobility Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: Two and three dimensional tests of advanced airfoil/rotor configurations will be initiated and the investigation of the effects of tip shape on rotor wake geometry will be completed. Tests of the "quiet" blade rotor will be completed and evaluation of concepts and devices for reducing rotorcraft vibrations will continue. Research will be continued to advance technology to support and advance exploratory development in propulsion and drive train components. Data will be derived to redefine points of separation within the impeller of a centrifugal compressor and to permit more precise positioning of splitter/half blades. The amount of backward curving and blade height to achieve best range will be re-evaluated. Also, combinations of diffuser types (vanes and pipes) and location of the diffuser entry station will be suitable for evaluation. Findings in these areas will complement and strengthen the overall joint program conducted with industry. The analytical techniques for complex structures effort will make extensive use of the simulated computer with redesigns for more efficient and rapid operation. The outdoor fatigue testing will continue and the laminate fatigue analysis will be extended to matched specimens and more complex stress distributions. The low cost composite fuselage program will select the best systems integration concepts for use with this type of structure. The usefulness of the new crash energy absorption test will be extended to more complicated loading cases such as torsion, bending and combined loads. Efforts to exploit mathematical concepts to enhance and strengthen the capability for technical risk assessment will continue. Work on reliability theory and transonic flow problems will also continue.

5. Program to Completion: This is a continuing program.

6. Major Milestones: Not Applicable.

7. Resources (\$ in thousands):

	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	5025	5365	6000	6400	Continuing	Not Applicable
Funds (as shown in FY 1979 submission)	4950	5210	5700	-	Continuing	Not Applicable

For FY 1979 and prior years the management and support costs for operating the Research and Technology Laboratories of the Army Aviation Research and Development Command were paid from program 6.58.01.A, Programwide Activities. For FY 1980 and future years these management and support costs will be paid from project funds. \$155 thousand has been added to this project for the four fiscal years indicated above to reflect this change and to provide comparability between funding figures. The fact that the FY 1978 and FY 1980 figures are slightly different is due to reprogramming \$80 thousand during the execution of the FY 1978 program, and a planned increase in emphasis in FY 1980.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #BH57

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Research in Scientific Problems with Military Applications  
Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

**A. DETAILED BACKGROUND AND DESCRIPTION:** This project supports research to increase knowledge in mathematics and the physical, engineering, environmental, and biological sciences directly related to long-term national security needs and to the solution of identified military problems. It provides part of the scientific base for subsequent exploratory and advanced developments in defense-related technologies and for new or improved military functional capabilities in areas such as communications, detection, tracking, intelligence, surveillance, air defense, weapons, munitions, aircraft, missiles, propulsion, land vehicles, guidance and control, navigation, energy conversion, materials, armor, structures, military construction, and personnel support. The physics and electronics programs are described in separate descriptive summaries. The chemistry research program in molecular sciences contributes to the technology base essential to solving the Army's requirements in camouflage, decontamination, development of high energy materials, and the synthesis of potting compounds, adhesives, and other new materials with special electrical, magnetic, or optical properties. The mathematics program is guided by two objectives: advancement of mathematical concepts and tools that are a prerequisite for a strong technology base in ballistics, heat transfer, testing, and computer software; and responsiveness to Army research, development, and operational agencies in the solution of their critical problems. Atmospheric research provides the technology necessary to delimit weather degradation of weapon systems utilizing a wide range of the electromagnetic spectrum. Terrestrial research is concerned with investigating earth surface and subsurface conditions and with remote sensing of those conditions relevant to military mapping and to assessment of limitations to mobility and construction. Biological sciences research in such areas as biochemistry and microbiology supports development of an adequate defense capability against chemical and biological weapons, contributes to reduced costs through increased lifetime of materiel and protection of subsistence items, lessens the impact of Army activities on natural environments, improves morale, and increases effectiveness of the soldier. Metallurgy and materials research contributes materials for mobility, firepower, and personnel protection for the Army through exploration of novel phenomena and generation of new understanding of the processing, structure, properties, degradation and protection of materials. Research in mechanics and aeronautics covers the fields of solid mechanics, fluid mechanics, and power generation with the objective of establishing a scientific base for improving performance and reliability while reducing cost and maintenance requirements of weapons, armor, structures, propulsion devices, and ground and air mobility. This project is divided into scientific areas as follows: 01-Atmospheric and Terrestrial Sciences; 02-Biological Sciences; 03-Communications Engineering and Electronics; 04-Materials; 05-Mathematics; 06-Mechanics and Aeronautics; 07-Physics; and 08-Chemistry. These broad groupings of research derive from the strong need of the Army to participate in and sponsor work in the scientific community for the development of new knowledge that contributes to the improvement of Army equipment.

**B. RELATED ACTIVITIES:** This is primarily a contractual program. It is coupled with and related to in-house laboratory work in the Defense Research Sciences, and close coordination is maintained with both the administrators and bench scientists in the laboratories. The Navy, Air Force, National Aeronautics and Space Administration, Department of Energy, National Science Foundation, Department of Interior, National Bureau of Standards, Department of Health, Education and Welfare, other



Project: #BH57

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Research in Scientific Problems with Military Applications

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

government agencies, government agencies of allied nations, and the industrial community conduct related research. Coordination to assure that there is no unnecessary duplication is accomplished by program reviews; exchange of program data sheets, research and technology resumes and technical reports; interservice and interagency liaison; and attendance and participation of Army representatives at annual reviews held by the Office of the Under Secretary of Defense for Research and Engineering. Coordination occurs through sponsorship of meetings and conferences, attendance at professional and scientific society meetings and review of scientific literature.

C. WORK PERFORMED BY: This program of grants and contracts with academic and not-for-profit institutions and industrial laboratories is managed by the US Army Research Office, Research Triangle Park, NC. The top five grantees or contractors are: University of Illinois, Champaign-Urbana, IL; Massachusetts Institute of Technology, Cambridge, MA; University of Wisconsin, Madison, WI; Stanford University, Stanford, CA; and the University of California, Berkeley, CA. There are in addition approximately 210 grantees and contractors. The value of the additional grants and contracts is \$21,400,000.

#### D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: A new technique significantly increases the accuracy of in-situ atmospheric density measurements, enabling more precise calculations of missile reentry. New information has been obtained on the optical properties of smoke and dust, leading to recommendations for improved lidar transmitters, receivers, hardware and software, and to a field program to provide a data base for optimization of lidar systems. Satellite observations of atmospheric radiance have been combined with conventional (radiosonde) low level wind observations to develop methods of solution of Army battlefield requirements for nuclear fallout prediction. Investigations of the response of unconsolidated soil sediments have important implications for the design of structures in seismically active (earthquake-prone) areas. Other work in soil mechanics enables prediction of the onset of deterioration of the stability of steep banks. Research on the process by which individuals eye-search for a target in a cluttered background are improving search strategies of military observers, camouflage design, and aerial photo interpretation. Studies of cell growth in the maintenance state have led to improvements in fermentation processes for production of food, medicines, and fuels, and for waste treatment with minimal removal of biomass. Work on initial-value problems for systems of hyperbolic conservation laws such as arise in a variety of continuum mechanics problems has been extended to systems of equations which describe many applications in gas dynamics and fluid mechanics. This provides a technique for identifying physically meaningful solutions when shocks are present. A high energy argon-fluorine ultraviolet laser has been developed with potential tactical applications including target designation, projectile guidance, and conversion of digitized mapping data to hard copy. New polymer systems have been developed for use as propellant binders which possess more desirable mechanical properties and promise ease of fabrication and the possibility of recycling - thus substantial cost savings. New chemiluminescent systems have been discovered which react catalytically with enhanced light production and promise the possibility of an internal "on-off" switch in these devices. Research on the mechanism of fretting-fatigue cracking, with application to helicopter components, has determined that a delamination process occurs and that improved resistance should be approached

Project: #BH57

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Research in Scientific Problems with Military Applications

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

through reducing susceptibility of surface layers to cracking by utilizing either hardened surfaces or very soft layers. Recent studies of high temperature heterogeneous flourine surface reaction kinetics led to techniques to design, evaluate, and select materials for uncooled nozzles for high power hydrogen fluoride chemical lasers, and in the diagnosis of performance of gas dynamic lasers employing the hydrogen-fluorine reaction. Observations of fracture of metallic alloys have been characterized into diagrams known as fracture-mechanism maps which show the region of stress, time, and temperatures over which a given mechanism of fracture is dominant, and is sensitive to changes in alloy composition, microstructure, and heat treatment. Spine functions have been used in the creation of efficient, adaptive techniques for comparing digital filters which produce derivative approximations. A computationally efficient algorithm has been developed which estimates the components of variance which in turn have been used to estimate all components of non-sampling errors. An analysis and a computer program for determining the drag of wing cross sections in stalled flow have been extensively tested and validated for a variety of airfoils. Combustion efficient and flame stabilization results for gas turbine type flames have been linearly correlated for the combustion of light fuels. A method for rapidly determining hydrodynamic bearing loads in squeeze film bearings used in gas turbine engines has been developed together with a technique for determining rotor unbalance response.

2. FY 1979 Program: The program is balanced between research responsive to a stated need or which supports ongoing programs in Army laboratories, and high-risk work with the potential of long-term contributions to future Army technologies. The electronics and physics programs are reported in separate descriptive summaries. The research areas partially listed here will provide the Army with the most advanced equipment and enable it to be responsive to its changing needs: atmospheric sensing and the physics of atmospheric aerosols, dust, and smoke; properties of earth materials and earth-fluid dynamic processes; sensing, mapping, terrain, and geodetic studies; research bearing on preservation, storage, safety, and nutritional quality of food and rations; pest control in stored products and protection of materiel from biodegradation; defense against biological and chemical weapons; environmental quality and rehabilitation; tailoring of the atomic and molecular structure of materials to evolve new properties hitherto undiscovered; synthesis and processing of high-performance materials at lower cost and with reproducible properties; evolution of efficient and reliable simulations and tests, both destructive and non-destructive, to ensure consistent performance and reliability of materials; development of mathematical tools and techniques including nonlinear analysis, system theory, and statistical methods; the mechanics of solid materials and of mechanisms; aerodynamics and flows characteristic of rotorcraft and missiles; fundamentals of ignition, combustion, deflagration and detonation of fuels, propellants, and explosives; and chemical synthesis and kinetics, gas phase dynamics, excited state chemistry and electro-chemistry. Approximately ten percent of the budget will be reserved for comprehensive, long-term research programs utilizing the scientific creativity and engineering inventiveness of the academic research community and broadening and strengthening the relationship between the defense and academic research communities.

3. FY 1980 Planned Program: The FY 1980 program will be a continuation of the work described in Section 2 above. The long-term basic-research component of the program will be increased. In addition to the work described in separate descriptive summaries for the electronics and physics programs, research emphasis will be placed in carefully selected thrust areas of potential importance to the Army. These include: aerosol physics and atmospheric transparency, basic

Project: #BH57  
 Program Element: #6.11.02.A  
 DoD Mission Area: #110 - Defense Research

Title: Research in Scientific Problems with Military Applications  
 Title: Defense Research Sciences  
 Budget Activity: #1 - Technology Base

to the understanding of atmospheric effects on signal transmission and obscuration; behavior of natural earth materials and the mechanisms involved in earth surface processes; defense against biological warfare; control of pests that damage stored products; surface-related mechanical behavior of solid materials, e.g., wear, fretting, corrosion fatigue and particle erosion; new methods of synthesis, processing, and testing of materials; basic knowledge of 3-dimensional large-amplitude shock wave propagation for fuze design and shock loading; kinematic and robotic techniques for improved design in power transmission, automatic weapons, and task performance in hostile environments; rotorcraft, missile, and rocket aerodynamics and the ballistics of projectiles; fundamental processes of fuel combustion; and the chemistry which underlies ignition and combustion of propellants and of gun tube wear and erosion. This project will support 115 in-house personnel (32 professional personnel and 83 support personnel).

4. FY 1981 Planned Program: The FY 1981 program will be based on a continuation of the work described in the foregoing sections. The flexibility to initiate new thrusts as promising scientific areas and corresponding Army needs become evident will be maintained.

5. Program to Completion: This is a continuing program.

6. Major Milestones: Not Applicable.

7. Resources (\$ in thousands):

	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Cost
ROUTE						
Funds (current requirements)	28081	31950	38646	50980	Continuing	Not Applicable
Program Funds	(25097)	(28500)	(34500)	(46180)		
Management and Support	(2984)	(3450)	(4146)	(4800)		
Funds (as shown in FY 1979 submission)	26576	31500	40000	--	Continuing	Not Applicable

For FY 1979 and prior years the management and support costs for operating the Army Research Office were paid from program element 6.58.01.A, Programwide Activities. For FY 1980 and future years these management and support costs will be paid from project BH57 funds. These costs have been delineated above for all four fiscal years to show comparability. The reduction in FY 1978 program funds was used to support high priority near millimeter wave research (\$1,079 thousand) and to defray the cost of development center moves (\$400 thousand). The \$3 million reduction in program funds for FY 1979 and the \$5.5 million reduction in FY 1980 reflect the Congressional directive that the Army not initiate the proposed new Defense Science and Engineering Program.



FY 1980 RUTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #03  
Project: #BH57  
Program Element: #6.11.02.A  
DoD Mission Area: #110 - Defense Research

Title: Communications Engineering and Electronics  
Title: Research in Scientific Problems with Military Applications  
Title: Defense Research Sciences  
Budget Activity: #1 - Technology Base

A. DETAILED BACKGROUND AND DESCRIPTION: The electronics and communications scientific area contributes to the technology base through the exploration of novel phenomena and the generation of new concepts. The objective is to provide a science and technology base in selected areas of electronics and communications to help satisfy present and future Army requirements. Research to obtain fundamental information is performed in the areas of signal generation, transmission, reception and processing; computer systems and communication theory; solid state electronics to include semiconductors, magnetics and dielectrics; and circuitry and networks. Work under this task will find application to a wide variety of Army problems in communications, command and control; surveillance, target acquisition and night observation; and electronic warfare. The Army's Science and Technology Objectives Guide and other planning documents are used as a basis for selecting fundamental research to meet long range requirements. Medium and short range requirements are delineated from Army laboratory plans, personal contacts with Army scientists and engineers and careful study of the applicable technology base versus existing state-of-the-art of science and technology. The engineering oriented nature of this task provides for extraordinarily efficient technology transfer among the industrial, academic and military communities. Also, because of the close coupling between the staff of the US Army Research Office's Electronics Division and appropriate Army laboratory staffs, a significant amount of work funded under this task is directly complementary to laboratory in-house efforts. Included is the Army portion of the support for the Joint Services Electronics Program, planned and funded jointly by the Army, Navy, and Air Force.

B. RELATED ACTIVITIES: This program is related to parts of the following projects in Program Element 6.11.02.A: AH43, Research in Ballistics; AH44, Research in Fluidics, Nuclear Effects and Ordnance Electronics; AH46, Research in Combat Surveillance and Target Acquisition; AH47, Electronic Devices Research; AH48 Electromagnetic Propagation and Antenna Research; AH49, Missile and High Energy Laser Research; AH51, Combat Support Research; AH63, Research in Electronic Warfare; A31B, Night Vision and Electrooptics Research; and B53A, Research in Atmospheric Sciences. Close coordination is maintained with the Navy, Air Force, Defense Advanced Research Projects Agency, the National Aeronautics and Space Administration, and the National Science Foundation. Coordination meetings are held on a regular basis.

C. WORK PERFORMED BY: This program is managed by the US Army Research Office, Research Triangle Park, NC. The top five contractors are: Massachusetts Institute of Technology, Cambridge, MA; University of Illinois, Champaign-Urbana, IL; Georgia Institute of Technology, Atlanta, GA; Stanford University, Stanford, CA; and the University of California, Berkeley, CA. The total number of additional contractors is 39; the total dollar value of these contracts is \$3,500,000.

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Technical/Scientific Area: #03

Project: #BH57

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Communications Engineering and Electronics

Title: Research in Scientific Problems with Military Applications

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

1. FY 1978 and Prior Accomplishments: Significant accomplishments have been made which advanced the state-of-the-art in electronics and communication sciences. The most accurate determination to date of the surface atomic structure of three important semiconductor surfaces was achieved; these materials are used extensively in the electronics industry, silicon being the principal semiconductor device material. The impact ionization coefficients in indium phosphide were unambiguously determined; this will contribute to the understanding of the ultimate performance limits of indium phosphide devices. A novel algorithm has been developed and is being used by several Army laboratories to calculate cost-effectively electromagnetic radiation/reflection patterns via a surface patch technique. A variety of ultra reliable and stable circuits have been simulated and designed as part of a very large scale integrated circuit program; several semiconductor companies have picked up these designs. A design method for obtaining permutation matrices resulting in minimum ambiguity will provide an exact method for radar signal design for optimal detection of radar targets. A theory and procedure for minimizing round-off noise in digital systems has been developed which will allow design of digital signal processing functions with minimum error. New theoretical results pertinent to the design of two-dimensional digital filters for signal processing were obtained; this result should find use in a number of Army applications. Major progress has been made in improving intelligent optical tracking concepts that can be used to locate, recognize, and track a large class of targets in noisy background scenes. This latter research has contributed to the solution of three major problems: real-time image decomposition, real-time structural tracking, and real-time control.

2. FY 1979 Program: Major emphasis is on establishing a sound science and technology base for advancing the state-of-the-art of and solving critical Army problems in data compression, transmission and reception, and other attendant problems in signal processing including the multi-signal environment. Much of the work is devoted to solid state electronics and antenna research. Present Army needs are great in the area of solid state electronics for reduction of power requirements and cost, and for increase in reliability and speed. Particular attention is being devoted to finding new electronic materials and understanding physical laws to enable the development of novel generators, detectors, and signal processors that will operate well into the millimeter wave region. Low profile antennas are being investigated with possible active electronic matching and tuning networks for use on manpack radios, vehicles, remotely emplaced battlefield sensors and terminal homing projectiles. To optimize payoff from this contractual Army research program these tasks are closely coordinated with Army laboratories with emphasis on improved reliability and operational capability of devices at reduced initial and maintenance costs. Coordination is maintained through personal contact, published guidelines, and a newly formed ad hoc Electronics Division Advisory Panel involving members from those Army laboratories having a primary involvement in electronics research. Block funded research programs at selected schools whose proposals address general Army needs as outlined above are being supported on an annual level of approximately \$200,000/program. At present two programs are active and two pending for consideration. The Joint Services Electronics Program at the following twelve universities is supported jointly by the Army, Navy and Air Force: Harvard University, Massachusetts Institute of Technology, Polytechnic Institute of New York, Columbia University, University of Illinois, University of Texas, University of

Technical/Scientific Area: #03

Project: #BH57

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Communications Engineering and Electronics

Title: Research in Scientific Problems with Military Applications

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

California-Berkeley, University of Southern California, Stanford University, Ohio State University, California Institute of Technology and Texas Tech University. The US Army Research Office has responsibility for the Army management of the Joint Services Electronics Program (JSEP), total funding for which amounts to \$6,500,000 with the Army providing \$2,400,000.

3. FY 1980 Planned Program: Much of the current electronics program will be continued as the accomplishments to date have been very good and the projects remain highly relevant. Increased research effort will be expended to overcome existing barrier problems in electronics such as thorough understanding of novel semiconductor materials for extremely high frequency applications, novel active antenna principles, and the detailed understanding of surface and interface effects in solid state electronics. It is expected that the investigation of these specific barrier problems will support the Army laboratories in meeting their objectives for more efficient and cost effective electronic systems. In addition, emphasis will be placed on novel electronic systems for which operational capability objectives exist but no active Army laboratory program has yet been initiated for lack of fundamental data. Specific basic research areas of interest are the field of night vision devices in the far infrared range, principles which govern generation, propagation and detection of millimeter to submillimeter waves, and the related investigations of parameters of materials to be used in these applications. Increased emphasis will be placed on the fundamental limits of submicron electronic devices. Research in digital signal processing and distributed computer processing will continue. It is planned to continue programs in six general topics: physical electronics; electron devices, antennas and electromagnetic detection; circuits, networks and related systems; signal processing, communications and related systems; and computers and information processing. Emphasis will be on areas of those basic studies which appear to be closest to engineering application. The JSEP and other block funded programs will be continued and possibly expanded. This scientific area will support 19 in-house personnel (5 professional personnel and 14 support personnel).

4. FY 1981 Planned Program: The planned program for FY 1981 is a continuation of the effort described for FY 1979 and FY 1980. The direct support of US Army laboratories for advancing the state-of-the-art of military electronic systems and in solving existing barrier problems will be increased. This will result in a reduction in lead time for systems development and at the same time, assure cost effectiveness with increased reliability. It is further planned to keep the laboratories informed about most recent accomplishments of the basic research community so as to enable Army researchers to conceptualize novel electronic systems to be built on the basis of more detailed application-oriented research. In regard to specific thrust areas in which funds will be expended, it is planned that the following research fields will receive first priority: millimeter and submillimeter waves, circuit integration, electronic materials, novel electronic engineering devices, communications in multisignal environments, distributed computer systems, and signal processing and information display.

5. Program to Completion: This is a continuing program.



Technical/Scientific Area: #03

Project: #BH57

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Communications Engineering and Electronics

Title: Research in Scientific Problems with Military Applications

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

6. Major Milestones: Not Applicable.

7. Resources (\$ in thousands):

	FY 1978 Actual	FY 1979 Estimated	FY 1980 Estimated	FY 1981 Estimated	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	5704	6751	8169	10818	Continuing	Not Applicable
Program Funds	(5300)	(6291)	(7485)	(10100)		
Management and Support	( 404)	( 460)	( 684)	( 718)		
Funds (as shown in FY 1979 submission)	5269	5965	6440	-	Continuing	Not Applicable

For FY 1979 and prior years the management and support costs for operating the Army Research Office were paid from program element 6.58.01.A, Programwide Activities. For FY 1980 and future years these management and support costs will be paid from project BH57 funds and allocated to the scientific area level. These costs have been delineated above for all four fiscal years to show comparability. The increased funding shown between the current requirements and the amounts shown in the FY 1979 RDTE Congressional Descriptive Summary has been used and will continue to be used for the support of block funded efforts and the expansion of the Joint Services Electronics Program. Block funding allows a group of established scientists to focus their efforts on a single scientific problem of concern to the Army.

FY 1980 ROUTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #07

Project: #BH57

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Physics

Title: Research in Scientific Problems with Military Applications

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

A. DETAILED BACKGROUND AND DESCRIPTION: The Physics scientific area contributes to the technology base through the discovery of new information and phenomena the understanding of which leads to the establishment of the laws of nature. This is accomplished by research in selected areas such as solid state physics, atomic and molecular physics, electromagnetic waves and optics. The objective is to provide the physical basis for the exploitation breakthroughs which will lead to the development of future technologies of interest to the Army. Through a vigorous interaction with Army laboratory managers having responsibilities in exploratory development, problems where the lack of fundamental information or understanding are limiting current developments are identified and pursued. Selection of research to be performed under this scientific area is guided by the Science and Technology Objectives Guide and other planning documents as well as recognition by the staff of new opportunities through an analysis of the open scientific literature. The results of this research impacts a wide variety of Army problems in command and control, surveillance and target acquisition, night vision, armaments, fire control and electronic warfare.

B. RELATED ACTIVITIES: This program relates to parts of the following projects in Program Element 6.11.02.A: AH42, Research in Materials and Mechanics; AH43, Research in Ballistics; AH44, Research in Fluidics, Nuclear Effects and Ordnance Electronics; AH46, Research in Combat Surveillance and Target Acquisition; AH47, Electronic Devices Research; AH48, Electromagnetic Propagation and Antenna Research; AH49 Missile and High Energy Laser Research; AH60, Research in Large Caliber Armaments; AH61, Research in Small Caliber Armaments; AH63, Research in Electronic Warfare; A31B, Night Vision and Electrooptics Research; and B53A, Research in Atmospheric Sciences. A direct exchange of common interests is accomplished among the Services and other government agencies on a continuing basis to avoid duplication of effort.

C. WORK PERFORMED BY: This program of grants and contracts with academic and not-for-profit institutions and industrial laboratories is managed by the US Army Research Office, Research Triangle Park, NC. The top five grantees and contractors are: Massachusetts Institute of Technology, Cambridge, MA; Stanford University, Stanford, CA; University of Arizona, Tucson, AZ; University of Pennsylvania, Philadelphia, PA; and University of Southern California, Los Angeles, CA. There are in addition 53 grantees and contractors; the value of these additional grants and contracts is \$2,750,000.

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Radiometric determinations of noise equivalent powers of a new quasi-optical system in the wavelength range of 1 millimeter to 120 microns have been performed which gives the highest sensitivity to date at a frequency of 670 gigahertz. Recent experiments have demonstrated the unique capabilities of millimeter and submillimeter microwave spectroscopy for studying fundamental processes in near millimeter wave lasers which will impact the Army's interest in obscured visibility operations. The possibilities of four wave mixing in multimode optical fibers has been examined theoretically

Technical/Scientific Area: #07

Project: #BH57

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Physics

Title: Research in Scientific Problems with Military Applications

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

and it has been found that complex image fields can be phase conjugated and amplified without loss of spatial information on a continuous basis with moderate pump powers and a few meters of fiber suggesting that four wave mixing in fibers is a serious candidate for real time holographic applications including image transmission and compensation for distorting media. For the first time it has been possible to obtain theoretically the face centered cubic binary phase diagram of copper and gold which is in agreement with the experimental one. This is an extremely significant achievement in light of the many unsuccessful attempts to obtain realistic phase diagrams from first principles. Grain boundary sliding and migration has been demonstrated for the first time in a finite temperature simulation of three- and two-dimensional solids showing that these processes can be simulated under fully dynamic conditions where the atomic motions of the grain boundary system are properly taken into account. Significant progress has been made in understanding in quantitative detail the speckle pattern that forms when laser radiation reflects from a rough surface. It has been found that sources of entirely different states of coherence may generate radiation fields that have identical distribution of intensity through the far zone. The use of such sources in various imaging systems and for optical testing would appear to be of considerable value for optics technologies and as decoys. Detailed new knowledge about inner shell photo- and charged particle ionization of neutral atoms as well as their ions has allowed the development of efficient photoionization codes which have been incorporated into larger codes designed for the study of effects of the disturbed atmosphere on radar transmission. The usefulness of combined scanning electron microscopy/scanning auger microscopy techniques applied to bore surface wear and erosion has been demonstrated. An outgrowth of studies of magnetoferroelectrics and divertible ferroelectrics has been the crystal growth and stereochemistry of a broad range of borocites which are important target materials in pyroelectric vidicons. A new form of piezoelectric polymer has been investigated which can be applied as a coating directly to metal parts which promises to simplify and improve fuze designs.

2. FY 1979 Program: The present program consists of 100 grants and contracts at universities, nonprofit research institutions and industrial laboratories. The area of electromagnetic technology includes elements of optics, laser physics and research relating to the near millimeter wave region of the electromagnetic spectrum. The latter reflects the emerging Army interest in obscured visibility operations. The current effort addresses research which will lead to the development of high energy, widely tunable infrared sources based upon both linear processes in gases and crystals and coherent Raman mixing in hydrogen gas. Upconversion techniques which include two photon resonant pumping in the nanosecond regime and use of the nonlinear optical coefficients of atomic vapors for harmonic and sum generation of infrared molecular lasers are being investigated. A sizeable effort exists in Schottky barrier detection, development of components and spectroscopic investigations in the near millimeter wave region. The area of energetic materials includes a theoretical effort that applies many body techniques to the study of the behavior of spin aligned hydrogen in some experimentally realizable configurations. The high specific impulse contained in the recombination of two hydrogen atoms with parallel spins to form molecular hydrogen is an extremely interesting system from an energy storage and release point of view. Cryogenic technology advances in recent years suggest that the formation and study of a gas of spin aligned hydrogen may now be possible. Nuclear quadrupole resonance spectroscopy combined with fast Fourier transform techniques are being applied to the study of the effects of additives on standard military explosives. The



Technical/Scientific Area: #07

Project: #BH57

Program Element: #6.11.02.A

Dod Mission Area: #110 - Defense Research

Title: Physics

Title: Research in Scientific Problems with Military Applications

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

unique properties of materials area contains an assortment of investigations that attempt to provide the physical basis for exploitation of classes of materials having unique properties which may be of interest to the Army in the long range. Included are investigations of man made semiconductors using advanced molecular beam epitaxy techniques, intercalation compounds with highly anisotropic electrical conductivity and noncrystalline materials which have structural as well as electronic applications interest. New techniques are being applied for the optical generation of a total spin population inversion within the excited states of a paramagnetic ion to study a variety of problems in nonlinear phonon physics including phonon amplification and maser action. The area of surface atom interaction includes several work units with the objective of providing a realistic interaction potential that could be used in studies of corrosion. Research performed to date has shown how such detailed knowledge of the potential can contribute to understanding of the mechanisms of pitting and wear. Pioneering work by scientists at Army Materials and Mechanics Research Center has shown that percolation theory can be used as a guide for the solution of such practical problems as the design of armor and noise abatement for helicopters. The Army Research Office is supporting basic research in percolation theory which will be closely coupled to the ongoing work at the Army Materials and Mechanics Research Center that seeks to determine whether a quantitative prediction theory can be developed that can take account of the complexity of real world problems such as penetration through graded armor.

3. FY 1980 Planned Program: In the coming year the program will be largely a continuation of ongoing efforts with the addition of new starts as funding permits. It is planned, for example, to increase the level of effort of research in the near millimeter wave region of the spectrum. The thrust will be toward spectroscopy where new information may lead to new source concepts. We will continue to examine gas dynamic excitation, and possible impurity level transitions in semiconductors for generation of near millimeter wave radiation. We may pursue the use of the high speed metal-oxide tunneling junction for down-conversion applications. The trends are toward more speculative concepts and efforts to elucidate the fundamental mechanisms of devices. Particular attention will be given to the higher frequencies which offer potential advantages for Army systems of the future. The program will include a solid investment in conventional optics. Attempts will be made to take advantage of breakthroughs in nonlinear optics which suggest that various parametric interactions may be used for reconstruction of wavefronts that have been distorted by optics or atmospheric turbulence. Consideration will be given to the advisability of initiating an experimental effort to form and study spin aligned hydrogen as an extension of and with guidance from the theoretical effort initiated in the past year. Nuclear quadrupole resonance spectroscopy combined with fast Fourier transform techniques will continue to be applied to explosive compositions. Support of research on solids which fall in the general categories of ferroelectrics, and particularly in aspects concerned with semiconductor ferroelectric surfaces, will be expanded. The research effort on piezoelectrics will be expanded with a view toward expanding the technical base for these important materials. This scientific area will support 18 in-house personnel (5 professional personnel and 13 support personnel).

Technical/Scientific Area: #07

Project: #BH57

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Physics

Title: Research in Scientific Problems with Military Applications

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: The FY 1981 program will be based on a continuation of the work described in the foregoing sections. The flexibility to initiate new thrusts as promising areas of physics and corresponding Army needs become evident will be maintained.

5. Program to Completion: This is a continuing program.

6. Major Milestones: Not Applicable.

7. Resources (\$ in thousands):

	<u>FY 1978</u> <u>Actual</u>	<u>FY 1979</u> <u>Estimated</u>	<u>FY 1980</u> <u>Estimated</u>	<u>FY 1981</u> <u>Estimated</u>	<u>Additional</u> <u>to Completion</u>	<u>Total</u> <u>Estimated</u> <u>Cost</u>
RDTE						
Funds (current requirements)	3961	4688	5799	7618	Continuing	Not Applicable
Funds (as shown in FY 1979 submission)*						

\* A separate Congressional Descriptive Summary was not submitted on this scientific area in FY 1979 as it was funded for less than \$5 million.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #All60

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Research in Large Caliber Armaments

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

- A. DETAILED BACKGROUND AND DESCRIPTION: Research in Large Caliber Armaments supports the Army's armament development programs in scientific areas of unique Army need for fundamental understanding as a basis for sound future weapons and munitions development. It consists of research in the following scientific areas: energetic materials (explosives, propellants, and pyrotechnics); ultra high pressure physics; and physics of armament (failure and reliability, advanced structural analysis, gun mechanism analysis, and control theory). In energetic materials, the thrust is toward development of new materials; understanding their behavior in ignition, initiation, combustion and detonation; and their effects and degradation to permit safer, more efficient and effective development, manufacture, use and disposal of munitions. The remainder of the effort is devoted to develop understanding of unique problems in armaments to permit the design of longer life, safer and more efficient gun tubes, recoil mechanisms and mounts.
- B. RELATED ACTIVITIES: Related research is performed by the Navy, Air Force, National Aeronautics and Space Administration and the Department of Energy. Coordination is accomplished by program reviews, exchange of program data sheets, research and technology resumes, technical reports, and liaison and attendance at scientific meetings and conferences. At the Office of the Secretary of Defense level coordination is achieved through active participation in Joint Technical Coordinating Groups and program reviews sponsored annually by the Office of the Under Secretary of Defense for Research and Engineering. Broader, multinational coordination is achieved through joint participation of Australia, Canada, United Kingdom and the United States in the Technical Cooperation Program and by data exchange agreements on various aspects of the program. This project is closely coordinated with Program Element 6.11.02.A project AH43, Research in Ballistics; and project AH61, Research in Small Caliber Armaments; and program element 6.26.03.A, Large Caliber and Nuclear Armaments Technology. The objectives of this project are also supported by contracts and grants placed by the Army Research Office under project BH57, Research in Scientific Problems with Military Applications in program element 6.11.02.A.
- C. WORK PERFORMED BY: This project is managed and directed by the Large Caliber Weapon Systems Laboratory at Dover, NJ. The in-house scientific efforts are performed at Large Caliber Weapon Systems Laboratory and Benet Weapons Laboratory at Watervliet, NY. Augmentation of the in-house effort is accomplished through contracts and grants with industry, universities, and other government agencies. The top five contractors that will receive money under this project are: National Bureau of Standards, Silver Springs, MD; Los Alamos Scientific Laboratories, Los Alamos, NM; Lawrence Livermore Laboratory, Livermore, CA; University of Iowa, Iowa City, IA; and Lehigh University, Bethlehem, PA. An additional 15 contractors will receive funds totaling approximately \$420,000 under this project.



Project: IAH60

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Research in Large Caliber Armaments

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: The role of free radicals in explosive initiation was investigated and it was found that trinitrotoluene (TNT) is sensitized by formation of the 2, 4, 6 trinitrobenzyl radical. Suppression of this radical could lower trinitrotoluene (TNT) sensitivity and help alleviate the premature explosion problem. Large-scale tests of heptane/n-propyl nitrate/fuel air explosive (FAE) was conducted resulting in reliable detonation of 4000 pounds of fuel sensitized with n-propyl nitrate and dispersed into a large fuel air explosive (FAE) cloud. A metastable conducting phase of cadmium sulfide has been produced which shows very interesting electrical and magnetic properties. This represents one of the first inorganic metastable (existing at atmospheric pressure) high pressure material states since the synthesis of diamonds. Quadratic and cubic isoparametric elements were successfully developed for the general purpose of structural analysis as well as for the analysis of cracked structures. Using the collapsed triangular elements, the correct orders of singularity can be obtained for either elastic fracture analysis or perfectly plastic fracture analysis. Using this approach, a fracture mechanics solution for the case of multiple cracks in a thick walled cylinder has been obtained. This solution shows, as compared to a single crack, a higher stress intensity for less than four cracks and significantly lower stress intensity for many cracks. This shows that the number of cracks present significantly affect fatigue life and fracture behavior.

2. FY 1979 Program: Promising new high-density explosive systems will be explored. Criteria for both standard and laser ignition of propellants will be sought. Determination of critical void size for subdetonative reactions will begin. Attempts will be made to desensitize trinitrotoluene by suppression of the 2, 4, 6 trinitrobenzyl radical. Studies of the synthesis and electrical properties of the pressure induced metastable phase of cadmium sulfide and similar materials will continue. Theoretical investigations into mechanisms of electrical conduction in these materials will be initiated which may lead to the prediction of other candidate materials. Studies will be initiated into the mechanisms of coppering and decoppering in order to define the means by which decoppering agents work to select the optimal resistant material, and into the measurement of the frictional characteristics of candidate refractory materials in combination with various rotating band materials. Efforts will be initiated to define a fracture criteria and fracture mechanics based test for the quasi-brittle penetrator materials that can be correlated with penetration behavior.

3. FY 1980 Planned Program: Novel thermally stable explosives will be synthesized. Surface mechanical properties of explosives and propellants will be determined. Propellant ignition and combustion and explosive initiation will be modeled. Criteria for propellant igniter characterization will be established. Pyrotechnic delays and infrared emitting formulations will be examined. Predictive models of heterogeneous detonation will be formulated. Erosion-retarding barrel coatings and improved infrared flash suppressing propellant additives will be sought. Efforts will continue in the investigation of cadmium sulfide and other materials to form, stabilize and study the electronic properties of metastable high pressure states. Wear and erosion efforts will concentrate on optimization of the properties and adhesion of chrome to include investigation of the use of trivalent chromium ions, the optimization of refractory coatings, characterization of the interface in refractory coated materials and

Project: #All60

Program Element: #6.11.02.A

Sub Mission Area: #110 - Defense Research

Title: Research in Large Caliber Armaments

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

development of appropriate substrates for refractory coating techniques including laser treatment. Weapon dynamic efforts will continue on development of dynamic response models for the variety of loading conditions involved and incorporation into the system analysis as it affects accuracy. The development of a fracture criteria and test procedure for homogenous kinetic energy penetrator materials will continue with initiation of efforts to develop a heavy metal composite penetrator material. Complete the development of a penetration mechanics solution for the 3-5 kilometer per second velocity range and apply the results to formulation of penetrator configuration. This project will support 85 in-house personnel (68 professional and 17 support personnel).

4. FY 1981 Planned Program: The synthesis and characterization of novel explosives and propellant ingredients and determination of their properties will continue. Ignition and combustion modeling and diagnostics will be refined. Elucidation of explosive initiation and heterogeneous detonation processes will continue. Research to find and develop infrared-emitting formulations and improved flash suppressors will continue. Effort will continue to attempt the synthesis of hydrogen base metallic phases, to synthesize new low absorption superconducting materials and to develop the technology for stabilizing high pressure phases. Continue work on optimization of the properties of chromium and other refractory metal coating techniques for enhanced erosion resistance, definition of degradation mechanisms, a stochastic approach to erosion design and optimal forcing cone design. The fracture criteria and test method for penetrators will be correlated with penetration performance and the concept of composite penetrator construction evaluated. Parametric studies will be conducted to define effects of support, damping and internal and external motion parameters on accuracy and predict these parameters to increase weapons platform stability.

5. Program to Completion: This is a continuing program.

6. Major Milestones: Not Applicable.

7. Resources (\$ in thousands):

	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Cost
NOTE						
Funds (current requirements)	4850	5160	5970	6500	Continuing	Not Applicable
Funds (as shown in FY 1979 submission)	5000	5160	6000	-	Continuing	Not Applicable

The reductions in FY 1978 and FY 1980 were reprogrammed to higher priority efforts.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #BS01

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Basic Research on Military Injury and Diseases

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

A. DETAILED BACKGROUND AND DESCRIPTION: The soldier is the most important component of the land combat system and must be maintained in a high state of medical preparedness for combat operations. In an effort to prevent diseased, injured, or psychiatric casualties from becoming lost to the combat commander, the science base is maintained to establish methodology used for medical assessment of health hazards or development of prevention or treatment modalities. To this end, basic research is conducted utilizing new and classical techniques of immunochemistry, histopathology, serology, immunology, microbiology and epidemiology on infectious diseases with existing or potential effect on military operations. Studies are directed toward better understanding of basic pathogenesis and militarily unique aspects of enteric viral and bacterial infections. Problems of the combat soldier include fundamental studies in areas of sepsis, wound healing, evaluation of current methods of treatment, biomedical factors associated with psychiatric ineffectiveness in the Army, and the physiologic impact of blast overpressure. Worldwide information on the distribution, ecology, taxonomy, and control of arthropod vectors of disease is developed in order to provide the epidemiological data base necessary for further progress in the protection of the health of Army personnel.

B. RELATED ACTIVITIES: Related work is performed under program elements/projects 6.11.02.A/BS02, Basic Mechanisms of Recovery from Injury; 6.11.02.A/BS03, Medical Defense Against Biological Agents; 6.11.02.A/BS05, Military Burn Research; 6.27.70.A/A802, Military Preventive Medicine and Tropical Diseases; and 6.27.70.A/A803, Drug Development. Complementary infectious disease research conducted by the Navy, National Institutes of Health, Department of Agriculture, and the Center for Disease Control is pertinent to this project. Army representation on Department of Defense coordinating committee and other intergovernmental agency coordination councils insures coordination at the working and administrative levels to prevent duplication of effort. Army scientists serve as consultants to the World Health Organization and have access to this organization's studies, reports, and publications. Other coordination is accomplished by personal contacts at the operating level, site visits by project officers, organization of technical symposia on selected topics, routine exchange of reports among staff and laboratory organizations, open publication of results in scientific journals, and distribution of research and technology resumés.

C. WORK PERFORMED BY: About 80% of the work is conducted by in-house laboratories at Walter Reed Army Institute of Research, Washington, DC, and affiliated field units in Thailand, Malaysia, and Brazil. Approximately 20% of the research is conducted under contracts with universities, nonprofit organizations, and industry. The top five contractors are Mount Sinai School of Medicine, New York, NY; Columbia University, New York, NY; University of Alabama, Birmingham, AL; Research Triangle Institute, Research Triangle Park, NC; and University of Hawaii, Honolulu, HI. Twenty-six other contractors are also funded in the amount of \$1,400,000.



Project: #BS01

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Basic Research on Military Injury and Diseases

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Improved survey methodology for studying ecology and control of disease vectors. Advanced technology for disease diagnosis and serologic surveillance permitting more accurate identification of factors influencing occurrence, distribution, and severity of disease. Expanded knowledge of cellular and subcellular alterations during infection providing the basis for more ready diagnosis and new concepts of intervention. Defined several immunological interactions between microbes and host white blood cells which may help explain the mechanisms of the immune response. Advanced technology for improved vaccine effectiveness by developing new data on structure and composition of microbes, subunits of microbes, and toxins. Developed a control strategy for selected arbovirus diseases based on information of insect bionomics. Studied the basic epidemiology of hepatitis, Dengue, and Japanese B encephalitis with emphasis on improved methods of virus isolation and serological detection. Devised a new method for the rapid identification of rubella virus. Purified and characterized Shigella toxin and its mode of action determined as a preliminary step in vaccine development. Studied Group B meningococcal cell wall fractions as possible vaccine precursors. Advances were made in the studies of the immunology of scrub typhus. Established a mouse screening system for the testing of candidate antischistosomal drugs. Proved immunity to schistosomiasis in rats to be transferrable by both antibody and lymphocytes. Established a successful snail colony with infection procedure which simplified identification of hosts from mosquito blood meals. Developed a new system for mass isolation of infected Anopheles mosquito salivary glands in order to obtain large numbers of viable malaria sporozoites. Developed data base from which new classes of effective antimalarial drugs were identified. Improved liposome encapsulation concept for prolonging effective drug levels and tested the theory that it provided a safer method of administering toxic drugs. Identified high-frequency hearing loss associated with low-frequency noise. Established science base and basic research objectives for high-impulse noise. Identified cellular relationship between overt behavior and emotional state. Directed psychiatry research at description of functional relationships between environmental factors in behavioral, neuroendocrinological, psychological, and psychiatric variables. Established data base for determining microwave exposure standards.

2. FY 1979 Program: Develop and test new concepts of interpreting epidemiologic data on vectors and disease. Determine rate and extent of cellular injury and regeneration during an infectious disease process. Expand knowledge of alterations in energy metabolism by the host during an infection. Demonstrate feasibility of using purified microbial products and new adjuvants to increase vaccine efficacy. Test concepts explaining the mode of transmission of hepatitis. Explore the mechanisms of cellular and serologic host responses to infectious organisms and their toxins. Study factors involved in directing the immune responses of lymphocytes in injury, infections, wound-healing and tissue rejection. Continue field studies to determine the genesis of arthropod-borne viral epidemics. Study immunochemical investigations of cell surface antigens of anaerobic infections. Direct emphasis toward gathering immunologic and pathogenic information about militarily important diseases such as Dengue, scrub typhus, leishmaniasis, trypanosomiasis, and respiratory disease to build a data base to permit further vaccine

Project: #BS01

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Basic Research on Military Injury and Diseases

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

development. Continue investigations on development of worldwide information on the ecology, biosystematics, distribution and control of arthropods involved in transmission of diseases affecting military personnel. Continue research on the development of methods and procedures for infectious disease diagnosis, prevention, and treatment. Continue work on pathogen-vector species relationships. Evaluate new and improved insect control procedures. Continue analysis on basic immunology and pathology of diarrheal disease to provide data necessary for vaccine development. Demonstrate effectiveness of a new class of drugs against leishmaniasis. Test feasibility of using the established data base to identify classes of drugs effective against parasitic diseases other than malaria and leishmaniasis. Establish data base and simulation model for impulse noise research. Characterize mechanisms of hearing loss associated with low-frequency noise. Define medical aspects of alcohol and drug abuse, translocation and attrition. Continue basic psychiatric research to provide the necessary data base for interpretation of military field studies and recommendations for prevention and/or treatment of breakdown in soldiers. Continue studies of physical and psychological responses to stress and develop behavioral principles. Continue work on adaptation to military environments with emphasis on minimizing attrition during basic training. Complete evaluation of blast overpressure associated with the major weapons systems (M198, M110 and M109 Howitzers; and Dragon) and recommend adequate hearing protection for crew use.

3. FY 1980 Planned Program: Broaden the data base on incidence and prevalence of disease and the factors which influence them. Test new diagnostic methods for sensitivity, specificity, and potential applicability to diseases of military importance. Define some of the microbial genetic and molecular properties responsible for virulence and antigenicity. Identify new microbial-host interactions that influence virulence and disease, antigenicity and immunity. Continue studies on the basic immunology and pathology of infectious diseases of military importance. Continue basic studies necessary on diarrheal diseases of the field soldier toward development of a vaccine. Study basic control technologies of arthropod vectors of disease to effectively develop pest management systems that are effective in reducing diseases of military importance. Demonstrate applicability of the drug science base to the process for safe, effective classes of drugs for further development, test, and evaluation. Expand drug data base to include new information about candidate classes of drugs for treatment of a variety of diseases. Continue study of human immune reactions during injury, wound-healing, and infections. Establish science base in neurophysiology and neuropharmacology for developmental efforts toward medical defense against chemical, biological, and radiological warfare. Provide access to industry state-of-the-art in these areas. Determine microwave energy absorbance characteristics of animal tissues. Generate exposure criteria for high-impulse noise. Develop computer model for study of low-frequency vibration in military vehicles. Design a simulation model for study of translocation. Establish a science base for determining toxicity of chemicals in the combat environment. Establish a neurophysiologic/neuropharmacologic science base to conduct basic research on medical effects of chemical agents, their mechanisms of action, and the best method of counteracting them. Continue psychiatric studies providing essential data for prevention and/or treatment of the combat soldier under stress. Develop further advances in health hazard (physical force) assessment associated with advanced concept weapons systems. Personnel to be utilized: 221, professional; 162, support.

Project: #BSU1

Program Element: #6.11.02.A

DOD Mission Area: #110 - Defense Research

Title: Basic Research on Military Injury and Diseases

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: Continue basic research on epidemiological parameters associated with infectious disease. expand developmental efforts to characterize microbial structural and genetic factors which influence virulence and the host immune response. Further basic efforts to identify host responses to infectious disease that can serve as diagnostic criteria and a basis for developing new concepts for treatment. Evaluate technology development to expand knowledge of immunologic mechanisms which can be employed in the development of new vaccines. Provide basic information on diarrheal diseases of the field soldier toward development of vaccine. Continue studies on body immune responses during injury, infections, wound-healing, and tissue rejection. Continue studies for control of insect vectors of arbovirus and parasitic diseases affecting military personnel. Maintain existing science bases for support of drug development, medical systems in chemical defense, and casualty management. Design acceptable, more rapid tests for toxicity assessment. Identify sleep loss decrements in performance and define optimum work-rest cycles in continuous operations. Provide data base utilizing basic psychiatric research for interpretation of military field studies involving prevention and treatment of mental breakdown.

5. Program to Completion: This is a continuing program.

6. Major Milestones: Not applicable.

7. Resources (\$ in thousands):

	<u>FY 1978 Actual</u>	<u>FY 1979 Estimate</u>	<u>FY 1980 Estimate</u>	<u>FY 1981 Estimate</u>	<u>Additional to Completion</u>	<u>Total Estimated Cost</u>
RDIE						
Funds (current requirements)	8770	10010	12172	14138	Continuing	Not Applicable
Funds (as shown in FY 1979 submission)	8373	10010	11226	-	Continuing	Not Applicable

Increase in FY 1978 funding is a reflection of internal reprogramming to support research on effects of jet lag on soldiers. Increased funding for FY 1980 is to establish a science base in neurophysiology and neuropharmacology for revitalization of developmental efforts directed toward medical defense against chemical, biological and radiological warfare. In addition, the science base is being expanded to include health hazard assessment of advanced concept weapon systems.



FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #A31B

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Night Vision and Electrooptics Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

A. DETAILED BACKGROUND AND DESCRIPTION: The Army must improve its ability to fight during periods of darkness and limited visibility. The objective of this project is to exploit new concepts for passive and active infrared (IR) detectors and imagers, new lasers, smart sensors, digital image processing, target signatures and atmospheric modeling. The most promising results of this project will be reduced to practice in exploratory development of day/night vision and tracking systems. Research on low cost, uncooled thermal imaging concepts is conducted to permit electrooptical target acquisition device solutions to such diverse high volume Army requirements as day/night riflesights, crew served weapon sights, IR drivers' and pilots' viewers and terminal homing seekers. This research emphasizes studies of lasers, pyroelectric materials, charge coupled device (CCD) imagers and thermooptical imaging concepts. Research on monolithic elements for far infrared focal plane arrays is directed at low cost, high performance thermal imaging requirements such as long range surveillance flirs and fire-and-forget autonomous seekers. Research addresses materials studies of 3-5 micron and 8-10 micron monolithic mercury cadmium telluride focal planes. The 1-2 micron image intensifier program contemplates a 10-20 fold improvement in photosensitivity over 3rd generation image intensifiers. This program capitalizes on the high levels of night sky glow emission in the 1-2 micron region and the high level of target contrast available. One to two micron imagers have the further important characteristic of providing more effective target camouflage penetration. Smart sensors and autonomous seekers are technology areas of intense military interest and importance. Research is required on automatic target acquisition algorithms or rules applicable to imaging seekers and multispectral cues. Research is also required as a basis for advanced critical military areas such as advanced target trackers and very high bandwidth compression for data links. The program on near millimeter wavelength lasers is directed toward the eventual development of laser radars and imagers operating near 1 millimeter to provide all-weather battlefield surveillance and target acquisition capability.

B. RELATED ACTIVITIES: Close coordination is maintained with the Navy, Air Force, and Marine Corps, other government laboratories, academia and industry to avoid duplication. Through the Joint Logistics Commanders, coordinating groups have been established to ensure that maximum use is made of limited assets, e.g., Navy is developing 8-14 micron 2nd generation infrared detectors while the Army is developing infrared detectors sensitive to 3-5 micron energy. The Army has responsibility for the configuration management of the 1st generation thermal imaging common modules used by all Services. In addition, an active international program of technical cooperation is maintained with many countries, particularly those of NATO and the Quadripartite countries.

C. WORK PERFORMED BY: Night Vision and Electro-Optics Laboratory, Ft Belvoir, VA. Representative contractors are: Rockwell International, Thousand Oaks, CA; Westinghouse Electric Corporation, Baltimore, MD; Varian Associates, Palo Alto, CA; Honeywell Incorporated, Minneapolis, MN; and Hughes Research Corporation, Malibu, CA. There will be seven additional contractors receiving approximately \$1,400,000.

Project: #A31B

Program Element: #6.11.02.A

Sub Mission Area: #110 - Defense Research

Title: Night Vision and Electrooptics Research

Title: Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: A new concept of lateral collection for Infrared (IR) detectors has produced high impedance detectors which are highly compatible with charge coupled device (CCD) signal processors. Such compatibility is required for the development of focal plane arrays. Selenium doped silicon detectors with high detectivities that operate at relatively high temperatures (120°K) have been successfully fabricated representing an important step toward IR detection for high performance seeker heads in smart munitions. The critical problems facing the development of uncooled thermal optical imagers were solved through the use of thin supporting membranes successfully coated with transducer material. Uncooled detectors may ultimately eliminate the need for cooling and concomitant complexities in night vision devices making them lighter, much cheaper and easier to use. Cueing by a scanning or seeker system refers to how the system detects and recognizes a target or a multiplicity of targets. A new cueing technique was developed for CCD implementation. Using this technique it is now possible to detect 95 percent of targets at 3 to 4 line pairs per target height. The method is implementable in a 3" x 3" x 6" volume. Remote battlefield surveillance requires dramatic improvements in image compression. Based upon automatic target detection and image decomposition techniques, a concept was developed which promises to be useful for transmission of a picture at greater than 1000 to 1 compression. In order to evaluate how clouds and smoke affect night/day viewing devices an aerosol scattering model has been developed which incorporates actual measurements taken at sites in the US and Europe and augmented by crucial "frequency of occurrence" statistics taken from Central Europe. Battlefield signature modeling is an Army area of emphasis. Preliminary target versus background average temperature models were developed for use in predicting all-weather effectiveness for seekers and scanners. High quantum efficiency was achieved in photocathode detectors (8 percent quantum efficiency) at 1.55 microns. Continued development of this photocathode will provide greatly improved image intensifiers with a greater detection range under all weather conditions. A gallium arsenide/gallium aluminum arsenide linear array charge transfer device with greater than 99 percent charge transfer efficiency at 10 megahertz was demonstrated. A new miniature laser was constructed. The design employs close coupling of rod, flashlamp, a dye-film Q-switch and an adjustable curved output mirror. The rod material being used is nickel pentaphosphate. Energy transfer mechanisms and spatial energy distribution and migration in the rod were established. New dyes for Q-switching lasers in the 1 to 2 micron region were discovered. Computer programs were developed in order to calculate the most efficient frequencies of solid-state laser operation based upon the crystal structure of the laser rod. Basic design data were acquired to improve the efficiency of pulsed carbon dioxide lasers. Recent work demonstrated near millimeter wave laser operation at 66 and 496 micrometers in both superradiant and unstable resonator cavity configurations. A novel analysis of unstable resonator cavities shows that the resonator configuration has inherent selective properties which are predictable. Unstable resonators give lasers higher beam purity and directionality. Night Vision and laser research has in the past provided the Army with important capabilities for day/night and foul weather operation.

2. FY 1979 Program: IR detection research is conducted to demonstrate charge transfer in selenium doped silicon detector/CCD structures essential for focal plane array design; and to define components leading to the development of IR scanning devices which combine second generation passive imaging with laser heterodyne active imaging. The aim of this research is to obtain

Project: #A11B

Program Element: #6.11.02.A

DoD Mission Area: #110 - Defense Research

Title: Night Vision and Electrooptics Research

Title: Defense Research Sciences

Budget Activity: #1 - Technology Base

Improved target location in smokes and foul weather. Research in uncooled thermal detecting materials includes work on the effectiveness of thermooptical transducers and imagers, solid state pyroelectric imagers, far infrared (IR) modulators and tunable far IR filters. This latter subject is important for protection of seekers and night vision devices against destruction by counter radiation. Visual perception research is directed toward cognitive brain/visual functions and studies of the retinal information processing system. Studies in target cueing and target tracking techniques are in progress in order to reduce the number of targets lost in high clutter, reduce false alarm rates and to develop algorithms to implement new image compression concepts. Tactical target signature versus background modeling is conducted to extend simple temperature models to include the whole range of European weather conditions. Research in the 1-2 micron region involves large area photocathodes with 5 percent uniform quantum efficiencies and low dark currents. Methodology to produce complete multilayer 1-2 micron sensitive structures by molecular beam epitaxy is being devised. Charge transfer devices are concerned with detection, injection, and charge transfer in mercury-cadmium-tellurium materials in order to ultimately develop a staring focal plane array for the IR region from 1 to 14 microns. Attempts are being made to achieve a uniform sensitivity of staring imaging detectors. Advanced laser source research is conducted to optimize the miniature laser cavity, to synthesize new dyes for miniature laser Q-switching and to develop theoretical methods for designing lasers and predicting their performance in the continuous wave and pulsed modes. Compact IR gas lasers and techniques for mixing laser beams (heterodyning) are being evaluated for performance in controlling laser output. Research is also conducted in integrated optics for lasers and prediction of effects of interaction of IR laser pulses with materials.

3. FY 1980 Planned Program: Monolithic intrinsic sensors will be grown by liquid phase epitaxy and concepts for laser-to-detector/local oscillator coupling concepts will be developed for IR detectors. These material concepts coupled with an analysis of focal plane device characteristics are critical to the design of advanced image processing in seekers and night vision devices. Research will demonstrate pyroelectric retinas with solid state readout. Two uncooled thermal imaging device approaches, the thermooptical filter and the solid state pyroelectric imager will be optimized. An investigation will be made into the total area which an observer can interrogate with a single fixation in order to aid in developing observer training techniques. Methods for matching actual and prerecorded imagery for smart munitions seekers and for selection of a critical aim point will be studied and efforts will be made to triple the detection range for automatic acquisition by tactical target arrays. Phase I of target signature modeling will be completed resulting in an analysis of the thermal contrast required by seeker systems based upon intelligence data. New periodic chart groups III-V and II-VI compounds will be grown to show the feasibility of a new class of Schottky - type detectors for IR devices. Epitaxial growth of high quality charge transfer device multilayers will be demonstrated. Based upon the results of acoustic signature detection work new programs will be initiated to exploit new adverse weather or smart sensor imaging concepts. Research in lasers will continue with organic dyes in adhesives and plastics for Q-switching and micro miniaturization of lasers and components for high speed integrated optical processing. Compact IR gas lasers will be optimized for performance and reliability. Transmission of short and ultrashort laser pulses through absorbers and smokes or natural mists and fog will be characterized in order to exploit the nature of these pulses for transmitting information. This project will support 58 in-house personnel (36 professional personnel and 22 support personnel).



Project: #A31B  
 Program Element: #6.11.02.A  
 DoD Mission Area: #110 - Defense Research

Title: Night Vision and Electrooptics Research  
 Title: Defense Research Sciences  
 Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: Improvements in passive and active sensors and image processing devices will be made in order to develop on-focal-plane image processing. Materials for uncooled thermal imagers will be optimized. Methods for automatic fusion of information and image compression will allow real time acquisition of multiple targets with minimal bandwidth and good anti-jam capabilities. Target vs background signatures will be acquired and analyzed for peculiarities which will be useful in developing viewing, cueing and tracking devices. A superlattice technology will result from novel work in molecular beam epitaxial growth of structures for image sensors. Charge storage and transfer in linear array cadmium telluride will be demonstrated. Other projected accomplishments include: studies of the feasibility of electrooptical processors to rapidly extract acoustic signatures for target location and identification; miniaturization of lasers and other electrooptical elements; investigations of adaptive optics for tactical lasers, advanced lasers, and laser detectors; and traveling wave sources, integrated sensors and other components for high power, near millimeter wave systems for observing, designating, and tracking on the battlefield.

5. Program to Completion: This is a continuing program.

6. Major Milestones: Not Applicable.

7. Resources (\$ in thousands):

	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Cost
RDT&E						
Funds (current requirements)	5890	6100	6900	7500	Continuing	Not Applicable
Funds (as shown in FY 1979 submission)	4730	4900	5400	-	Continuing	Not Applicable

Effective during FY 1979 the electrooptics mission previously performed by the Combat Surveillance and Target Acquisition Laboratory under project AH46, Research in Signal Detection and Low Energy Lasers, is being transferred to the Night Vision and Electro-Optics Laboratories at Ft Belvoir, VA under project A31B Night Vision Devices Research. Concurrently the names of both projects are being changed. The funds for FY 1978 and FY 1979 have been restructured for both projects to show comparability with FY 1980 and FY 1981. The funds actually transferred from project AH46 to project A31B are: \$1,260,000; \$1,200,000; \$1,100,000, and \$1,200,000 for the fiscal years from 1978 to 1981 respectively. The fact that the figures above are slightly different is due to reprogramming \$100 thousand during the implementation of the FY 1978 program, and a planned increase in emphasis for FY 1980.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.21.05.A

DoD Mission Area: #151 - Materials and Structures

Title: Materials

Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	9905	11275	13611	13280	Continuing	Not Applicable
AH84-01	Advanced Materials for Aircraft	2524	2545	3556	3229	Continuing	Not Applicable
AH84-02	Advanced Materials for Armament	1949	2076	2814	2269	Continuing	Not Applicable
AH84-03	Advanced Materials for Armored Vehicles	1381	2214	2264	2127	Continuing	Not Applicable
AH84-04	Advanced Missiles for Missiles	720	392	383	390	Continuing	Not Applicable
AH84-05	Advanced Materials for Ground Combat Vehicles	511	1405	1430	1968	Continuing	Not Applicable
AH84-06	Advanced Materials for Bridging	188	327	351	357	Continuing	Not Applicable
AH84-07	Mechanics of Materials	660	752	800	813	Continuing	Not Applicable
AH84-08	Advanced Materials for Solution of Special Problems	1379	888	1292	1397	Continuing	Not Applicable
AH84-09	Advanced Materials for Laser Hardening	593	676	721	730	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** The work under this program is exploratory development of improved and advanced materials directed primarily toward four generic Army weapon systems, their mission, and support equipment: aircraft, armament, ground combat vehicles, and missiles. The remainder will address special problems with varied requirements for materials technology. The objective of the program is to conduct exploratory development to produce improved materials and processes for use in the design, construction, and operation of Army weapon systems to satisfy superior tactical and strategic performance requirements and reduced life cycle costs. Specific Army need is reflected in the following examples: accelerated wear of helicopter gears and drive train components with resultant excessive vibration and costly maintenance requirements; excessive wear and erosion of gun tubes producing short barrel life, inaccurate ballistics performance and high operational

Program Element: #6.21.05.A

DOD Mission Area: #151 - Materials and Structures

Title: Materials

Budget Activity: #1 - Technology Base

costs; current inventory of ground combat vehicles fabricated from hull and armor materials incapable of defeating long rod/high density penetrator munitions; high vulnerability of crew and personnel of ground combat vehicles to wide-angle backface spall generated by antiarmor munitions; limited capability of missile radome materials traveling at high mach numbers to withstand rain erosion and maintain good electromagnetic transmission properties; limited capability of current weapon system materials to provide adequate protection against high energy laser threats; and lack of acceptable levels of reproducibility of ballistics performance of high density penetrator munitions due to inadequate advanced penetrator core materials.

C. BASIS FOR FY 1980 RDTE REQUEST: Work will be conducted to overcome mission deficiencies and satisfy mission needs outlined in paragraph B and to exploit technological opportunities in advanced materials development. It will consist of development of improved materials and processes for evaluating and improving the mechanical, thermal, and fatigue properties, and the resistance to erosion and corrosion of lightweight, high strength alloy systems, reinforced composites, advanced ceramics, adhesives for bonded joints, and coating materials for corrosion prevention. Major thrusts will include development and characterization of high strength-light weight materials to provide increased mobility/maneuverability for ground combat vehicles and Army helicopters; improved materials, and advanced armor to defeat penetrator munitions; high strength/toughness alloys for gun barrels that shoot farther and maintain their accuracy longer; high modulus lightweight materials to withstand high-G forces of advanced missiles; significantly improved materials to satisfy growing demand of helicopter drive train components to increase time between overhaul and reduce cost of maintenance/overhaul; and innovative new materials and materials processes for weapon system failure analyses and repair. The overall objective will be to develop and characterize new and improved materials specimens to provide life cycle cost reduction, needed improvements in weapon system performance and reliability, and significantly improved maintainability.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total	
					Estimated Cost	Not Applicable
RDTE						
Funds (as shown in FY 1979 submission)	11205	11275	12015	Continuing		

Funding decrease in FY 1978 resulted from adjustments to fund higher priority requirements. Increase for FY 1980 provides funding for the new major thrust in metal-matrix composite materials for helicopters.

E. OTHER APPROPRIATION FUNDS: Not applicable.



Program Element: #6.21.05.A

DoD Mission Area: #151 - Materials and Structures

Title: Materials

Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** The work in this program is part of a three-part research, exploratory development, and advanced development program for materials. The goals of this program are to produce new materials products, new materials specifications, and prototype specimens made of new materials. Applied research and exploratory development are conducted in the following areas: metallurgical techniques and alloy improvements; organic materials; ceramic materials; composite materials; mechanics of materials; laser hardening of materials; and test evaluation methods. All these efforts are aimed at producing improved materials for use in the design, construction, or operation of Army material to satisfy superior performance requirements, to reduce costs of weapon systems acquisition and lifetime ownership cost of weapon systems.

**G. RELATED ACTIVITIES:** The Navy, Air Force, other Government agencies, and allied nations have complementary programs in one or more of these materials areas. Coordination within the Department of Defense is achieved through bi-annual update of the Materials Technology Coordinating Paper and meetings of the Office of the Deputy Under Secretary of Defense Research and Engineering ad hoc Services Materials Laboratories Council. Coordination with the nonmilitary federal agencies is effected through participation in activities of the National Materials Advisory Board of the National Academy of Sciences--National Academy of Engineering and the Interagency Council on Materials, and with the US Department of Energy. International coordination is effected through participation in the Technical Cooperation Program with Australia, Canada, New Zealand, and the United Kingdom and the Structures and Materials Panel of the Advisory Group for Aerospace Research and Development of the North Atlantic Treaty Organization.

**H. WORK PERFORMED BY:** Approximately 75% of the work will be accomplished in-house at the Army Materials and Mechanics Research Center, Watertown, MA; US Army Armament Research and Development Command, Dover, NJ; Natick Research and Development Command, Natick, MA, US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; and the US Army Missile Research and Development Command, Huntsville, AL. Typical contractors are: AVCO, Everett, MA; Massachusetts Institute of Technology, Cambridge, MA; Stanford Research Institute; Palo Alto, CA; Desert Sunshine Corporation, Phoenix, AZ; Georgia Institute of Technology, Atlanta, GA; University of Illinois, Urbana, IL; US Steel Corporation, Pittsburgh, PA; Rockwell International, Thousand Oaks, CA; and Iowa State University, Ames, IA.

#### **I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

1. **FY 1978 and Prior Accomplishments:** Accomplishments include implementation of new characterization techniques for composite helicopter blade materials; graphite/aluminum cross-plyed doubler plates were fabricated, mounted on CH-47 helicopter transmission housing, and tested for vibration reduction; identification of causes for unacceptable variability of tungsten penetrator ballistics performance and recommendation of corrective action; development and recommendation of armor materials/design for improved TOW vehicle; improvement of materials for blast resistant tank track program; development and evaluation of new composite materials joint designs for mobile military bridging. Prototype Army helicopters engine blades were fabricated from high strength, high temperature filament reinforced superalloy composites. Enhancement of aluminum and steel armor against both anti-personnel projectiles and munitions fragments by incorporating Kevlar spall-suppression backup liners; development of an improved rubber quick-disconnect gasket for refuel operations in arctic climates; development of camouflage coating materials for the PATRIOT missile radar antenna elements.

Program Element: #6.21.05.A

DoD Mission Area: #151 - Materials and Structures

Title: Materials

Budget Activity: #1 - Technology Base

2. FY 1979 Program: Development of improved polymeric, ceramic, and composite materials; alloys of aluminum, titanium and uranium; determinations of fatigue, fracture, corrosion, environmental deterioration, biodegradation, and fungal attack of military materials; the development of high density projectile munition materials and fragmenting munition materials; investigation of structural and radome materials with laser hardening characteristics; further development of electroslag remelted and maraging steels; development and application of techniques for coatings for radar camouflage and for the prevention of erosion, corrosion, and environmental deterioration; development of lightweight materials and design requirements for rapidly deployable combat bridging; development of solutions to technical problems associated with composite materials processing and bonding; and determination of laser protection levels provided and required by combat uniform materials.

3. FY 1980 Planned Program: Develop new high temperature alloys and composites, upgrade the corrosion and high temperature properties of coatings, and improve stress and fatigue properties all to satisfy requirements for improved combat vehicle engines. Improve alloy processing procedures for helicopter gear and bearing materials. Determine improved metal-matrix composite materials fiber/alloy systems, and establish a data base for fiber matrix systems. Correlate high density munition materials properties and processing conditions with reproducible ballistic performance. Performance of improved steel powders for fragmenting munitions will be determined as a function of stress and strain rates. Evaluation of layered coatings for improved wear and erosion resistance of small arms gun tubes. Mathematical and experimental parameter determinations will be made for the performance of foamed materials layers and armor plates subsystems subjected to mine blast. High strength, lightweight materials will be developed for vibration, fatigue, and noise reduction in advanced helicopters. Advanced ballistic protection materials for tank track suspension systems will be developed and evaluated. Work to provide microstructural integrity of fused silica for missile radomes, testing, improved radome and nose tip materials, and improved thermal battery materials will be continued for advanced Army missile systems. Investigation of the effect of humidity and temperature on the stress corrosion cracking of critical weapon systems components will continue. Mechanisms of environmental deterioration in organic composite materials in advanced weapon systems will be determined and agents developed for retarding degradation. Flammability characteristics of advanced organic materials will be evaluated. Work will be initiated to optimize laser protection, ballistic protection, and structural performance for Army aircraft and missiles. A new major thrust will be initiated to determine the processing parameters for a wide spectrum of metal-matrix composites for helicopter drive-train systems and mobile bridges. There will be 128 professional and 171 support personnel involved in these efforts.

Program Element: #6.21.05.A

DoD Mission Area: #151 - Materials and Structures

Title: Materials

Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: Weapon systems structural work will continue to concentrate on the rheocast fabrication process to exploit cost reductions, on evaluating environmental effects on magnesium protective coating systems, and on improved adhesive bonding for advanced weapon systems. Correlate structural properties and component performance on military vehicle gear and bearing materials. Improved penetrator materials of extruded uranium and tungsten alloys will be fabricated and tested. Fragmentation tests will be conducted for cylinder materials machined for 105mm and 155mm projectiles. Effects of thermal stresses and various gaseous environments on cracking nucleation and crack propagation in layers formed during use of gun tubes will be investigated. Textured materials for armor application will be subjected to ballistic firings and analysis. Work will be continued on powder metallurgical processes with aluminum alloys and strain hardenable aluminum-magnesium-lithium (Al-Mg-Li) alloys for helicopters. Assessment and design guides for use of foamed materials to reduce mine blast damage to armor vehicles will be developed. Fire-resistant and fire-barrier armor materials construction for ground combat systems applications will be developed and evaluated. Work will continue on microstructural analyses of fused silica, rain erosion resistance of silicon nitride, fabrication techniques, and the improvement of thermal battery materials. Effects of humidity and temperature on stress corrosion cracking of stored missiles will be determined for a series of steel and aluminum alloys. Bridging materials work will be focused on fiber reinforced organic and metal-matrix composite materials, lightweight metallic components, and design of shafting, truss, and coupling members. Rapid-cure thermosetting resin-based composites, continuous fiber reinforced thermoplastics and improved lightweight impact resistance structural foams components will be developed for improved prototype tank treat and suspension system materials. Effects of tropical environments on new lightweight magnesium alloys will be evaluated. Prototype, thermoplastic, foam/chopped Kevlar, fiber-reinforced, epoxy, combat vehicle track components will be developed and evaluated. The new major thrust in metal-matrix composite will be continued.

5. Program to Completion: This is a continuing program.



FY 1980 RDTI CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.21.11.A  
 RDT Mission Area: #134 - Environmental Sciences

Title: Atmospheric Investigations  
 Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
AIH/1-21	Automatic Meteorological Technology	1100	520	830	560	Continuing	Not Applicable
AIH/1-22	Middle Atmospheric Effects on Electro-Magnetic Transmission	460	0	0	0	Continuing	Not Applicable
AIH/1-23	Atmospheric Characterization	900	2053	2145	2400	Continuing	Not Applicable
AIH/1-24	Remote Atmospheric Sensor techniques	1050	1455	1135	615	Continuing	Not Applicable
AIH/1-25	Atmospheric Models for Electro-Optical System	885	980	1010	1115	Continuing	Not Applicable
AIH/1-26	Meteorological Techniques for Artillery	740	695	840	892	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Mission needs respond to Army: (1) to provide its own weather support forward of Division, for weapon systems, and for hydrologic and flood forecasting, (2) and requirements contained in the Department of Defense Atmospheric Transmission Plan, 28 October 1978, which the Army must meet to satisfy its responsibilities to all three services (Army, Navy, Air Force). This program addresses the urgent need to develop meteorological techniques and equipment essential in the planning and support of combat operations. The impact of weather and battlefield conditions (dirty battlefield) on sophisticated weapon systems employing Electro-Optical (E-O) and near millimeter wave (MMW) devices must be determined. These devices are frequently, often seriously, downgraded by natural aerosols such as fog, dust, smoke and by the products of battle. Models must be developed to characterize the various conditions in order to design and deploy future weapon systems. Meteorological conditions can seriously effect tactical operations. Near real-time weather intelligence is essential in planning combat operations and direct support of weapons systems. For example meteorological error is one of the largest for artillery fire, and first round accuracy cannot be achieved without improved meteorological data. Remote wind sensors are required

Program Element: #6.21.11.A  
DoD Mission Area: #134 - Environmental Sciences

Title: Atmospheric Investigations  
Budget Activity: #1 - Technology Base

to increase the standoff range (and survivability) of both the attack helicopters and battle tank. Specific objectives are to develop: (1) Meteorological techniques and equipment for direct and indirect support of Electro-Optical (E-O) and target acquisitions systems, armor, smoke, high energy laser (HEL), and artillery precision guided munitions; (2) E-O atmospheric propagation and optics computer codes for determining effects on E-O systems; (3) quantification of potential battlefield environments at wavelengths from visible to near millimeter (MM); and (4) remote atmospheric sensors to increase armor, artillery, and helicopter fire control accuracy increasing probabilities of first round hits.

C. BASIS FOR FY 1980 RTE REQUEST: Complete data for E-O sensor atmospheric effects library for Europe and provide computer simulation of the battlefield environment for E-O and near millimeter wave (NMMW) systems. Conduct field measurements for dust and smoke validation tests, and infrared (IR) and NMMW transmission through dust and smoke. Demonstrate exploratory development models for the tank gunnery crosswind module and visiocellometer. Evaluate the short range helicopter remote sensor mounted on the AH-1 helicopter.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Total	
				Additional To Completion	Estimate Cost
RTE Funds (as shown on FY 1979 submission)	5340	5703	6100	Continuing	Not Applicable

Funding decrease in FY 1978 (\$205K) resulted in termination of nearly all research effort related to tactical applications of meteorological satellites due to low priority of requirements for this effort. Funding decrease in FY 1980 (\$140K) will result in termination of research in middle atmosphere effects on Army communication systems due to lack of stated requirements.

E. OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.21.11.A

DoD Mission Area: #134 - Environmental Sciences

Title: Atmospheric Investigations

Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** Develop techniques and equipment for meteorological support of Army battlefield operations and for design, development, operation and employment of: weapon systems that use electro-optical (E-O) sensors, armor, artillery, Precision Guided Munitions (PGMs), smoke, and high energy laser (HEL). Develop E-O atmospheric propagation and optics codes for determining total battlefield environment effects on E-O systems. Identify and quantify studies of battlefield environments. Develop remote atmospheric sensors in direct support of weapon systems, especially armor, helicopter and artillery. Objectives of this program will be accomplished by sophisticated field measurements of atmospheric parameters; preparation of E-O sensor atmospheric effects information data for battlefield zones of Europe, Mid-East, and the Arctic which can be used to determine atmospheric effects on E-O and near millimeter wavelength (NMMW) systems; use of remote sensors, such as the remote automatic weather station (AN/TM-30), crosswind sensors for armor, antiarmor and helicopters; development of predictive models for battlefield smoke and obscuration; application of meteorological satellite techniques for battlefield precipitation location; and the development and evaluation of equipment and techniques to account for meteorological effects on battlefield effectiveness of Army artillery and target acquisition systems.

**G. RELATED ACTIVITIES:** 6.11.02.A, Atmospheric Sciences; 6.27.30.A, Cold Regions Engineering Technology; 6.37.41.B, Meteorological Equipment Development; and 6.57.02.A, Support of Development Testing. Work is coordinated within the Department of Defense by the Under Secretary of Defense Research and Engineering (USDRE). USDRE participates in the Interdepartmental Committee on Applied Meteorological Research. Direct coordination is maintained with: Project Manager, Smoke/Obscurants, Army Materiel Systems Analysis Agency/US Army Training and Doctrine Command, Harry Diamond Laboratory, High Energy Laser Systems Project Office/Missile Research and Development Command, Test and Evaluation Command, White Sands Missile Range (WSMR), Dugway Proving Ground, Air Force, Navy, National Oceanographic and Atmospheric Agency, Environmental Protection Agency, Panel XII (Meteorology) of the NATO Army Armaments Group and the US Army European Mesometeorology Advisory Panel.

**H. WORK PERFORMED BY:** The Atmospheric Sciences Laboratory, White Sands Missile Range, NM, is the in-house developing organization responsible for the program. Of the \$5.703M program in FY 1979, approximately 68% is in-house and 32% is contractual. Contracts exist with the following: Physical Science Laboratory, New Mexico State U, Las Cruces, NM: Raytheon Co., Wayland, MA; Stanford Research Institute, Menlo Park, CA; Particle Measuring Systems, Boulder, CO; Oregon Graduate Center, Beaverton, OR. Twenty-eight additional contracts total \$1.27M.

#### **1. PROGRAM ACCOMPLISHMENT AND FUTURE PROGRAMS:**

**1. FY 1978 and Prior Accomplishments:** Upgrade Joint Technical Coordination Group/Munitions Expenditures Smoke Obscuration Code extending code coverage to IR spectra where major Army target acquisition systems operate, e.g. the Forward Looking Infra-Red (FLIR). Initiated Electro-Optical (E-O) sensor atmospheric effects data library for Europe to develop E-O and Near Millimeter Wave (NMMW) propagation models to simulate effects of dirty battlefield environments on the performance of E-O and NMMW systems. Characterized the atmosphere for adverse weather conditions at Baumholder, Federal Republic of Germany (FRG), for the Night Vision Electro-Optical Laboratory (NVEOL), and the Surveillance and Target Acquisition Radar for Tank Location and Engagement (STARTLE)



Program Element: #6-21.11.A  
Sub Mission Area: #134 Environmental Sciences

Title: Atmospheric Infrared Technology  
Budget Activity: #1 - Technology Base

system. Characterized the atmosphere during Copperhead ground fog experiment at Fort Ord, CA, to assess effects of a European (Germany) type fog on Copperhead. Conducted field measurements for infrared transmissions at OPALIE site at Heppen, FRG, under low visibility conditions caused by atmospheric aerosols to provide a data bank and validation for use by tri-Service and NATO modelers in characterizing transmission/meteorological interactions on weapon system. Atmospheric characterization measurements were made during smoke/dust tests at Dugway Proving Ground, UT, and White Sands Missile Range (WSMR), NM, to provide required data/information to the Army Materiel & Systems Analysis Agency (AMSSAA), Night Vision Electro-Optical Laboratory, US Army Missile Research and Development Command and the US Naval Weapons Center for dust/smoke models addressing effects of dust and smoke on terminal homing devices and target acquisition systems such as the Forward Looking Infra Red (FLIR) and the Heavy Antitank Weapon (HOW). Successfully conducted feasibility test on integrated helicopter remote wind sensor for fire control accuracy of the fire control system of the Advance Attack Helicopter (AAH). Accomplished initial evaluation/calibration of 1.06 micrometer pulse laser remote crosswind sensor and performed feasibility investigation for development of 10.6 micrometer crosswind sensor for the fire control system of armor (tanks) for acquisition of integrated crosswinds between tank and target to improve fire accuracy. Completed field measurement system for optical turbulence and crosswinds in support of the tri-Service IEL Systems Test Facility, WSMR. Developed transmission and diffusion algorithms for calculating "nowcast" solutions for smoke munition expenditures for Army artillery. Completed software for predicting required smoke munitions expenditures to achieve obscuration utilizing terrain effects and Air Force forecast inputs for use by Army Artillery and the Army Smoke Program Manager. FY 78: In-house \$3.32M, contractual \$1.81M.

2. FY 1979 Program: Complete and distribute Interim European battlefield obscuration model for Army users to provide a computer simulation of battlefield environment effects on Electro-Optical (E-O)/Near Millimeter Wave (NMMW) sensors in European scenarios. Characterize and model dust and debris cloud growth from high energy bursts and artillery firings for combat modelers for one on one or force-on-force war games. Conduct low visibility infrared transmission measurements and dust/smoke validation tests to provide data base deficiencies and validations for combat modelers. Complete tri-Service High Energy Laser (HEL) System Test Facility measurement system for gases and particulates. Demonstrate use of a hand held cloud height and visibility (visiometer) indicator for use in support of close combat aircraft and Precision Guided Munitions (PGMs). Demonstrate sound ranging and smoke expenditure reduction models. Continue Electro-Optical (E-O) climatology for central Europe to provide information on occurrence of adverse weather conditions to systems performance analysts and combat modelers. Design/fabricate infrared optical remote crosswind sensor as part of a multisensor for tanks. Determine feasibility of using tank Forward Looking Infra-Red (FLIR) to obtain crosswind measurements for fire control accuracy. Assess meteorological effects of and determine meteorological requirements for long-range Army artillery accuracies. Develop techniques for automating the recording of sound arrival times on sound ranging equipment to provide the Army with an improved passive target acquisition capability. Initiate development of techniques for E-O systems deployment/employment for the Intelligence Preparation of the Battlefield. Complete survey of available remotely piloted vehicle (RPV) sensors and systems and analyze their relationship to potential meteorological applications. FY 79: In-house \$3.87M, contractual \$1.82M.

Program Element: #6.21.11.A  
Doll Mission Area: #134 - Environmental Sciences

Title: Atmospheric Investigations  
Budget Activity: #1 - Technology Base

3. FY 1980 Planned Program: Construct E-0 sensor atmospheric effects library for Europe and provide computer simulation of the battlefield environment for Electro-Optical (E-0) and Near Millimeter Wave (NMMW) systems to give an advanced computer simulation of dirty battlefield environmental effects on E-0 and NMMW sensors for European scenarios. Conduct field measurements for dust and smoke validation tests and infrared (IR) and NMMW transmission through dust and smoke for weapon systems performance analysts and combat modelers. Demonstrate exploratory development models for tank gunner crosswind module and visioellometer and cloud ceiling measuring device for use by Army aviation. Evaluate the short range helicopter remote sensor mounted on the AH-1 helicopter. The sensor will improve helicopter firing accuracy at increased standoff range thereby increasing enemy casualties and helicopter survivability in combat. Assess cost trade-off options for the integration of ceiling and visibility sensor into an advance remote automatic weather station (RAWS) to provide needed high-resolution visibility and cloud height measurements in the forward combat areas. Complete calculator solution for Tactical Fire Direction Center (TACFIRE) smoke and chemical application to convert smoke related parameters, such as munition expenditure rates, to chemical applications and integrate such codes into field computer systems. Evaluate Remotely Piloted Vehicle (RPV) meteorological sensors for Electro-Optical (E-0) atmospheric characterization. Complete techniques for use in tactical weather intelligence for Intelligence Preparation of the Battlefield. FY 1980: In-house \$3.650M, contractual \$2.310M. Number of personnel supported with requested FY 80 funds: Professional 45; Support 18.

4. FY 1981 Planned Program: Complete and distribute final European battlefield obscuration model: Army benefits are a well-documented, validated computerized European battlefield environment simulation model for design, analysis and trade-off studies for E-0 and NMMW weapon systems. Complete dust and smoke validation tests for weapon systems performance analysts and combat modelers. Continue field measurement for slant path Infra-red (IR) transmission under limited visibility conditions to enhance weapons system performance (such as Copperhead). Complete sound ranging automation, optimizing sound ranging techniques, and provide to Army Artillery for validation. Develop techniques for atmospheric absorption, crosswind, optical turbulence, and transport and diffusion at the tri-service High Energy Laser (HEL) Systems Test Facility, WSMR. Complete final field tests and evaluation of short range (500m) helicopter remote wind sensor for the fire control system of the Advance Attack Helicopter (AAH). Minimize the tactical configuration of the Advanced Attack/COBRA helicopter remote wind sensor to include increased standoff range, kill effectiveness and survivability. Validate techniques to utilize meteorological sensor aboard an RPV for E-0 atmospheric characterization. Complete exploratory development model of advanced RAWS (with cloud height and visibility). Evaluate and test RAWS design/configuration under field conditions, and validate design and demonstrate the Army Aviation and Intelligence Users prior to entering Advance Development under Letter of Agreement (LOA)-1503A. Continue adaptation of mesoscale meteorological information E-0 system utility and demonstrate capability for tactical weather intelligence. FY 81: In-house \$3.612M, contractual \$1.970M.

5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.21.20.A

DOD Mission Area: #152 - Ordnance Technology

Title: Nuclear Weapons Effects, Fluidics  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	TOTAL FOR PROGRAM ELEMENT	FY 1978	FY 1979	FY 1980	FY 1981	Additional to Completion Continuing	Total Estimated Costs Not Applicable
			Actual 11546	Estimate 5788	Estimate 6641	Estimate 9325		
AH25	Nuclear Weapons Effects Research, Fluidics Technology		11546	5788	6641	9325	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Secretary of Defense in a report to Congress on the Theater Nuclear Force Posture in Europe, in 1975 stated that theater nuclear forces must be sufficiently survivable to have a credible retaliatory capability and secondly, that NATO conventional forces should be able to operate satisfactorily in a nuclear environment. To meet these requirements, a Nuclear Weapons Effects Research program to assure the survivability of Army materiel during and after a nuclear exchange is required. Environmental definition, hardening assessment, developing of hardening fixes, and evaluation of the nuclear survivability of operational forces are parts of the program. The fluidic technology program provides a coordinated, Army-wide program for the design, development, testing and feasibility demonstration of fluidic systems for use in Army materiel. Fluidic systems offer the potential of greatly improved reliability, availability and maintainability, and reduced life-cycle costs while providing improved end-item performance. This is a Single Program Element Fund (SPEF) wherein an Army laboratory is funded in one PE to perform two or more tasks that are not necessarily related.

C. BASIS FOR FY 1980 RDT&E REQUEST: Nuclear hardening of critical Army equipment is essential to mission accomplishment. The approach is to evaluate and improve nuclear survivability of critical fielded tactical systems, to develop cost-effective nuclear hardening techniques for systems in development, to transfer the technology to system developers, and to evaluate the effectiveness of hardening on fighting unit survivability. Hardening fixes for critical equipment from the forward edge of the battle area through Corps will be available in FY 1980. Technology will be developed to insure that hardness is maintained during production and fielding of systems. The hardened shelter program will begin. Tests of fluidic controls for diesel engine fuel control, and back-up fuel controls for high mobility combat vehicles will be continued. Program coordination, critical component development, and reliability will continue.



Program Element: #6.21.20.A  
 WMD Mission Area: #152 - Ordnance Technology

Title: Nuclear Weapons Effects, Fluidics  
 Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>	<u>Additional to Completion</u>	<u>Total Estimated Cost</u>
NOTE Funds (as shown in FY 1979 submission)	8275	5788	7124	Continuing	Not Applicable

The FY 1978 column in the FY 1979 submission did not include \$3.271 million for the fuzing task that was executed in this PE in FY 1978 because that task was transferred to PE 6.26.03.A in FY 1979. The total effort estimated to be required in FY 1980 was more optimistic than the current estimate reflects.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.21.20.A  
DOD Mission Area: #152 - Ordnance Technology

Title: Nuclear Weapons Effects, Fluidics  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The nuclear weapons effects (NWE) research program is an integral part of the Army Nuclear Survivability Program. The NWE research program is structured to provide adequate environmental definition for all nuclear weapon effects; to develop appropriate hardening fixes; to provide technology for including nuclear survivability hardening during design and testing of systems in development. This is the Army's only program to provide the technology that enables development of equipment that will be survivable on the tactical nuclear battlefield. Fluidics offer low cost, high reliability, intrinsically safe control systems that can operate in harsher environments than other types of controls, and are adaptive particularly to suspension systems for vehicles, and fuze-arming controls. This Program explores the applicability of fluidics to candidate systems sufficiently to demonstrate the feasibility of transferring to system development as cost-effective improvements.

G. RELATED ACTIVITIES: Nuclear weapon effects research is part of a Tri-Service effort in coordination with the Defense Nuclear Agency. It is a vital and essential part of the Army Nuclear Survivability Program. It is related to Program Element (PE) 6.36.04 (Advanced Weapons Effects and Nuclear Munitions), D153 (Nuclear Effects Support Team), which provides for technological assistance to materiel development agencies. All appropriate programs for missiles, combat vehicles, command control and communication systems, and battlefield intelligence systems are supported by these efforts. Fluidic technology follows up on research in PE 6.11.02.A, Research in Fluidics, Nuclear Effects, and Ordnance Electronics. Additionally, it supports the work of the Joint Technical Coordinating Group - Fluidics.

H. WORK PERFORMED BY: Harry Diamond Laboratories, Adelphi, MD; Ballistic Research Laboratory, Aberdeen Proving Ground, MD; US Army Electronics Research and Development Command, Fort Monmouth, NJ; US Army Missile Research and Development Command, Redstone Arsenal, AL; White Sands Missile Range, NM; US Army Tank Automotive Research and Development Command, Warren, MI; Air Mobility Research and Development Laboratory; Fort Eustis, VA; US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA. Contractors include General Electric, Schenectady, NY; AVCO, Wilmington, MA; University of Florida, Gainesville, FL; Shock Hydrodynamics, Ventura, CA; Physics International, San Leandro, CA; GTE Sylvania, Needham, MA; Science Applications, La Jolla, CA; Kaman Sciences Corporation, Colorado Springs, CO; Mission Research Corporation, San Diego, CA; Kaman Avidyne, Boston, MA; Braddock, Dunn and McDonald, Albuquerque, NM; Unidynamics, Phoenix, AZ; Northrop Corporation, Hawthorne, CA; Denver Research Institute, Denver, CO; Lovelace Foundation, Albuquerque, NM; ENX Engineering Incorporation, Wayne, IN; Martin-Marietta Corporation, Orlando, FL; Bendix Corporation, Detroit, MI; Honeywell, Minneapolis, MN; AResearch Manufacturing Company, Phoenix, AZ; and Try-Tec Corporation, Columbia, MD.

Program Element: #6.21.20.A

DDO Mission Area: #152 - Ordnance Technology

Title: Nuclear Weapons Effects, Fluidics

Budget Activity: #1 - Technology Base

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: A comprehensive electromagnetic pulse (EMP) program was initiated under which survivability levels were established for all Army single and multi-channel radios, repeaters, and telephone terminals. Electromagnetic pulse prototype fixes for multichannel and single channel communications systems were developed and transferred to the appropriate project managers. Product improvement proposals to incorporate increased levels of EMP survivability into hardware have been initiated. Blast survivability levels for several helicopters, and the LANCE and PERSHING missile systems and various other equipment have been identified and many improvements made. A cost-effective radiation hardening program was begun. Radiation protection factors for US and other tanks were developed. An EMP calculational capability for near surface bursts was completed and immediately made available to the materiel development community. Technology was developed permitting nuclear hardening of electronic shelter designs. Antenna survivability product improvements were identified. Support was provided to Project Managers of many major systems in development such as the XMI tank, the PATRIOT Air Defense System, and the COPPERHEAD antitank missile. Force survivability analysis began in FY 1977 and a field test was successfully conducted. Simulation facilities for Army and Tri-Service use were maintained. The first large area combined thermal and blast synergistic test was performed. Effort in the area of maintaining nuclear hardness during production and after the fielding of systems was expanded. All such effort was directly related to the Army Nuclear Survivability Program. Fluidics design and process data were obtained for injection molding of fluidic explosive initiators, temperature sensors and vortex rate sensors. Nuclear weapons effects on fluidics, effects of contamination of fluids, fluidically controlled dampers, and electrical to fluidic interface devices were examined and developed. Feasibility of a tank turret stabilization control system was demonstrated. Joint service turbine engine fuel control systems were passed to the Navy and Air Force for product improvement application to small auxiliary power system turbines. Critical components for diesel engine fuel controls and suspension systems were developed. A low cost servo valve was evaluated and environmentally tested. Evaluation of fluidic actuators for missile flight controls was completed. Fluidic power supplies for the General Support Rocket System (USRS) were passed to the project manager for system integration.

2. FY 1979 Program: The nuclear survivability technology programs to harden appropriately critical command, control, and communications equipment on the tactical battlefield will be nearly completed. Low altitude EMP and non-ideal blast environmental definition programs will continue. Hardening of the Army's tactical fire control system (TACFIRE) will continue. Hardening for the Army's new family of radios (Single Channel Ground Airborne Radio Systems) will continue as planned. Expansion of efforts will continue to establish a hardness assurance program during production and after fielding of systems. Low altitude electromagnetic pulse (EMP) hardware fixes for appropriate critical equipment will be developed. Efforts to calculate and measure the combined nature of nuclear effects on equipment will begin. The Tactical Operation System (TOS) will be hardened to high altitude EMP (HAEMP). The hardened shelter program will continue. Nuclear survivability efforts in support



Program Element: #6.21.20.A

DD Mission Area: #152 - Ordnance Technology

Title: Nuclear Weapons Effects, Fluidics

Budget Activity: #1 - Technology Base

of emerging technology such as optical and laser components, fluidic devices, and micropower integrated circuits will continue. Engine test of fluidics fuel controls will be developed, a laboratory evaluation of backup turbine fuel controls will begin, feasibility on semi-active suspension systems will be demonstrated, and a fuel mass flow-meter for helicopters will begin development.

3. FY 1980 Planned Program: Efforts on the tactical fire control system (TACFIRE) high altitude electromagnetic pulse (HAEMP) hardening and balanced vulnerability analysis (VA) will be continued. HAEMP VA of Air Defense command and control systems will be initiated. Balanced hardening fixes will be developed for low, medium, and high capacity multichannel communication systems. The vulnerability and hardening of a mobile electric power (MEP) unit for selected communication systems will be completed. An optimally hardened communication shelter design will be initiated. Source development and support for simulator facilities will continue. A total of 53 civilian personnel are involved in this effort. The FY 1979 Fluidics projects will continue in FY 1980.

4. FY 1981 Planned Program: The hardening of TACFIRE to HAEMP upset and radiation will be completed and the blast and thermal hardening initiated product improvement proposals will be documented. Balanced threat efforts on command and control systems will begin. The HAEMP vulnerability of the Improved HAWK will be assessed. The same program will be initiated on the PATRIOT system. Backup fuel controls for tank gas turbine engines will be completed. Development of sensors and low cost controllers for Remotely Piloted Vehicles (RPV's) will be continued.

5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.22.01.A

Sub Mission Area: #145 - Guns and Related Technology

Title: Aircraft Weapons Technology  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	1177	1910	2101	2311		Not Applicable
DM96	Aircraft Weapons Technology	1177	1910	2101	2311	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program generates concepts and demonstrates the technical feasibility for application of advanced armament techniques and weapons to Army aircraft for delivering ordnance to destroy, neutralize, or suppress those targets jeopardizing ground or airborne forces in the conduct of the land combat role.

C. BASIS FOR FY 1980 RDTE REQUEST: Fabrication of a flyable Auto-Cueing device will be completed and an investigation of long range fire control options for point targeting from helicopters will be initiated. Development of new munition concepts for helicopter weapons to defeat point targets at long ranges to include options for defense against other helicopters. New concepts for using aerial rockets, including terminal trajectory correction techniques, will also be investigated.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
		1227	1910	1506	Continuing
					Not Applicable

Increase in FY 80 funding is required to address new technology research in support of the requirement for long range point targeting and fire control technology.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.22-01.A

DoD Mission Area: #145 - Guns and Related Technology

Title: Aircraft Weapons Technology

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: Aircraft weaponization technological development efforts are directed toward strengthening the technology base of aircraft weaponry by providing the Army inventory with advanced aircraft weapons and improved munitions. The project effort is directed towards generating concepts and developing technological advances necessary for performance, life and operation for aircraft weaponization applications. Specifically, there are four areas of research and development: gun and mount, fire control, aerial munitions, and aerial rockets.

G. RELATED ACTIVITIES: Close liaison is maintained with the other military services and industry to avoid duplication of effort. The Army participates in the Tri-Service Joint Technical Coordinating Group for Air Launched Non-Nuclear Ordnance, an organization chartered at the major field command level. This group provides a medium for exchange of technical information and determination of joint use implications. An Army representative serves on the Air Munitions Requirements and Development Committee, an organization within the office of the Secretary of Defense. One of the functions of this committee is the establishment of joint service requirements and development of air munitions. Related Advanced Development work is conducted under Program Element 6.32.06.A, Aircraft Weapons; and Engineering Development is under Program Element 6.42.02.A, Aircraft Weapons.

H. WORK PERFORMED BY: Aviation Research and Development Command (AVRADCOM), St. Louis, MO; Armament Research and Development Command (ARRADCOM), Dover, NJ; US Army Missile Research and Development Command (MIRADCOM), Huntsville, AL; US Army Materiel Systems Analysis Agency (AMSAA), Aberdeen, MD. Contractors: General Electric, Birmingham, NY; Westinghouse, Baltimore, MD; Firestone, Akron, OH; Aerojet General, Downey, CA; Boeing Aerospace, Seattle, WA; and Texas A&M University, College Station, TX.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Competitive hybrid constant recoil concepts have been evaluated. Technical determination was made to integrate advanced gun componentry to demonstrate advanced technology. High Impulse Gun Airborne Demonstration (HIGAD) project was initiated. Signal processing schemes were formulated to allow acquisition and tracking of fixed ground targets in clutter environment for millimeter wave radar. Optical sight model validation was performed which establishes a basis for comparison of advanced target acquisition methods with known optical performance. Analysis of helicopter air-to-air ballistic dynamics was initiated. A comparative cost effectiveness study of helicopter TOW and SHILLER anti-armor missile systems was completed with the TOW selected as the most cost effective. Four contenders for a second generation area weapon were evaluated and the 30mm automatic gun was selected. A cost comparison of potential third generation antitank guided missiles was completed. Studies were conducted to determine aerial weapon system reaction forces and blast effects on helicopters. Simulation models were developed to evaluate gun-type weapons with respect to weight, rate of fire, cost, accuracy and reliability. Additionally, concepts for a helicopter launched anti-radiation missile were evaluated. Fire control parameter analyses related to extending the range capabilities of ballistic and rocket weapons, remote control (drone) delivery systems, and night/all weather systems were conducted. Two firing tests, using the AH-1G helicopter, one turret and one wing mounted gun; were conducted to identify the different variables contributing to total firing error and magnitude of each error source. The spin insensitivity and penetration potential of a shallow cone shaped charge warhead were also demonstrated. Initial firing demonstrations using 2.75



Program Element: #6.22.01.A

DoD Mission Area: #145 - Guns and Related Technology

Title: Aircraft Weapons Technology

Budget Activity: #1 - Technology Base

such rockets indicated that the accuracy of placement of submunitions in the target area is insensitive to variations in rocket trajectory, but does require that an appropriate drag device be incorporated into each submunition. Advanced ammunition concepts in telescoped configuration were investigated for optimization. An advanced gun system component integration effort was initiated to demonstrate the feasibility of integrating developments in constant recoil, closed loop fire control, and associated stabilization. Advanced gun design efforts addressed the advantages and disadvantages among three competing gun designs utilizing telescoped, folded and separate loading concepts. Evaluation of millimeter wave radar application to Army helicopters for air-to-ground and anti-helicopter roles continued. Automatic target cueing methodology was initiated for television and FLIR (Forward Looking Infrared) sensors. Effort was directed toward providing ammunition test quantities for the High Impulse Gun Airborne Demonstration. The mass focus fragmentation submunition research, the design of the fuse/wave shaper package and secondary trajectory stabilization efforts for submunitions were initiated. Development of a low cost terminal trajectory correction capability for the 2.75 rocket continued.

2. FY 1979 Program: Fabrication of HIGAD (High Impulse Gun Airborne Demonstration) hardware will be completed. Laboratory testing of the high impulse gun system will be initiated with the system installed on an AH-1G airframe. The optimally controlled turret model with torque disturbance inputs will be validated in support of the HIGAD program. A prototype auto target cueing system to provide a target detection capability for use with remote view imaging sensors will be fabricated and flight tested. This effort will establish the basis for the fabrication of a fully operational airborne auto target cueing system. Testing of the millimeter wave fire control system for air-to-air/air-to-ground fire control techniques will be completed and fabrication of hardware for a feasibility demonstration will begin. Initial work on smooth bore concepts for the high impulse gun, capable of defeating enemy armor, will begin. 2.75 in rocket terminal trajectory correction design effort will complete a design package that can be adopted as a product improvement for the 2.75 inch rocket. A precision point fire weapon concept using armed Remotely Piloted Vehicles in providing long-range standoff capability against enemy armor and hostile aircraft will be pursued. A feasibility demonstration of low cost radio frequency (RF) target marking system to allow integrated use of cannon and rockets on selected targets will be initiated.

3. FY 1980 Planned Program: Design of a fire control system compatible with long-range weapons will begin. Benefits gained from mast-mounted sensors, millimeter wave radar, optimal filtering techniques, forward looking infrared (FLIR) and television techniques will be utilized in a long-range standoff fire control design which can be integrated with attack helicopter weaponization. Auto cueing efforts will yield data necessary to evaluate system effectiveness of optimal filtering techniques. Tactical projectile feasibility investigation will address the application of Spinning Tubular Projectile (STUP) for the anti-helicopter role, long rod penetrators for helicopter weapons, and the development of a lightweight steel cartridge case. This effort will emphasize breadboard hardware and ballistic testing to provide a final engineering package. The terminal trajectory correction effort, correction control items and signal processor will be designed. Evaluation of the principle option for an imaging armed RPV, addressing sensor package configuration, weapons options and interface, terminal management for ordnance launch and automatic target cueing techniques, will continue. These exploratory development efforts employ twenty five professionals at various technical laboratories.

Program Element: #6.22.01.A  
DoD Mission Area: #145 - Guns and Related Technology

Title: Aircraft Weapons Technology  
Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: Long range fire control options such as second generation Forward Looking Infrared (FLIR) and remote sensing, etc., will be investigated. A flyable auto target cueing unit will be flight tested and upgraded. Anti-armor and anti-helicopter munitions will be investigated and tested. Terminal trajectory correction options for delivery will be addressed.

5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.22.02.A

Title: Aircraft Avionics Technology

DoD Mission Area: #125 - Command and Control

Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
ALL85	Aircraft Avionics Technology	5171	5768	6342	6977	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides the exploratory development technology base for Army avionics and air traffic control. The primary thrust is to enhance operations of Army helicopters in the known enemy threat environment during day, night, and adverse weather missions. Nap-of-the-Earth flight is required for battlefield survivability. In addition to challenging helicopter crews, the nap-of-the-earth environment poses significant technical problems for system and subsystem designers. Areas of investigation include communications, environment sensing, navigation, air traffic management, landing systems, cockpit instrumentation, and digital avionics systems.

C. BASIS FOR FY 1980 RDTE REQUEST: The FY 1980 request is based on the need to seek new solutions to significant tactical problems. The FY 1980 program will build on earlier successes in the areas of night navigation and pilotage, digital avionics, and system architecture, CO<sub>2</sub> (carbon dioxide) laser based detection of wires and other obstacles, hybrid navigation systems, tactical landing systems, and tactical air traffic control. Emphasis will be placed on readying new subsystems and techniques for flight demonstration in the Systems Test Bed for Avionics Research under Program Element 6.32.07.A (Avionics Equipment).

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Cost Not Applicable
	5850	5768	5769		



Program Element: #6.22.02.A  
DOD Mission Area: #125 - Command and Control

Title: Aircraft Avionics Technology  
Budget Activity: #1 - Technology Base

FY 1978 program was reduced in order to fund higher priority programs by reducing effort in communications, navigation, landing guidance, environment sensing, and digital avionics systems. Funding for FY 1980 was increased, permitting an increase in planned efforts in digital avionics systems, communications, navigation, and air traffic management as part of a policy of deliberate growth in technology base funding.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.22.02.A

DDO Mission Area: #125 - Command and Control

Title: Aircraft Avionics Technology

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: This program explores new ideas, concepts, and techniques in aviation electronics. The objective of the program element is to determine the feasibility of applying new aviation electronics technology to Army aircraft and related ground equipment. Particular emphasis is placed on helicopter operations and crew workload at night, in adverse weather, and at low level/nap-of-the-earth (NOE) altitudes.

G. RELATED ACTIVITIES: Related programs of the other Services, the National Aeronautics and Space Administration, the Federal Aviation Administration, and other organizations are followed with committees, working groups, and joint developments to take advantage of techniques that can be applied to Army problems. Resources are concentrated on problems which are Army unique or not addressed by other development activities. This program element leads to developments in Program Elements 6.32.07.A (Aircraft Avionics Equipment) and 6.42.01.A (Aircraft Avionics).

H. WORK PERFORMED BY: US Army Avionics Research and Development Activity, Fort Monmouth, NJ. Contractors include: Marchand Electronics, Incorporated, Greenwich, CT; Bendix Corporation, Baltimore, MD; United Technology Research Center, E. Hartford, CT; All Cutler-Hammer, Farmingdale, NY; Honeywell, Incorporated, Avionics Division, St. Louis Park, MN; Fairchild Camera and Instrument Corporation, Syosset, NY; Hughes Aircraft Company, Culver City, CA; American Electronics Laboratory, Incorporated, Wall Township, NJ; Litchford Electronics, Incorporated, Northport, NY; Grumman Aerospace Corporation, Bethpage, NY; Hazeltine Corporation, Greenvale, NY; Sperry Rand Corporation, Phoenix, AZ; Sencor, Incorporated, Moorestown, NJ; ROLM Corporation, Santa Clara, CA; Communications Components Corporation, Costa Mesa, CA; and ITT Research Institute, Chicago, IL, and Ohio University, Athens, OH.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

##### 1. FY 1978 and Prior Accomplishments:

a. Successfully bench/flight tested hover sensor applique. Successfully bench tested breadboard components of electronic counter-countermeasures (ECCM) adaptive antenna applique. Ground and flight tested optimum location and radiation patterns of new high frequency loop antenna derived from computer modeling. Conducted flight tests of improved AN/ASN-43 heading reference unit which resulted in a product improvement program on the AN/ASN-43. Developed a standard flight test plan to evaluate state-of-the-art attitude and heading reference systems. Constructed computer model of Global Positioning System/Doppler hybrid navigation system. Demonstrated concept of Very Lightweight Air Traffic Management Equipment (VLATME) using miniaturized L-Band interrogators for air traffic control. Successfully completed concept evaluation program designed to assess ability to land helicopters using decelerating approaches in confined tactical sites. Completed conceptual design study for crossbanded microwave landing system/transponder system. Completed Army/Air Force microwave landing system polarization tests. Initiated tests of manpack size KU-band landing system. Initiated development of Lightweight Multifunction Tactical Beacon System (LMTBS) which is designed to provide navigation/position fixing, approach and landing, hazard warning, formation flying, collision prevention and station keeping. Redesignated Terrain Trend Sensor (TTS) to incorporate lighter weight, smaller components with greater reliability. Demonstrated feasibility of Wire Obstacle Warning System (WOWS) using charge coupled

Program Element: #6.22.02.A

DOD Mission Area: #125 - Command and Control

Title: Aircraft Avionics Technology

Budget Activity: #1 - Technology Base

devices. Demonstrated multifunction Laser Obstacle/Terrain Avoidance Warning System (LOTAWS) scanning laser system. LOTAWS has detected 1/8 inch wires at a range of 1500 feet, and power lines out to one mile. Flight tested night navigation and pilotage system. Designed, fabricated, and programmed Microprocessor Interface Unit (MIU) for use in flight tests of integrated target acquisition and navigation systems. Completed conceptual system design and integrated Digital Modular Avionics Program (DIMP) bench facility with Tactical Avionics System Simulator (TASS) using MIL-STD-1553A data bus.

b. Initiated three-year program for Army Digital Avionics System (ADAS) which will lead to development of an all digital helicopter. Continued development of night navigation pilotage system which will enable the aircrew to navigate effectively in the nap-of-the-earth (NOE) environment, day or night. Took delivery of multiplex hardware for integration into the digital hot bench, and developed bus control software. Initiated Avionics System Architecture (AVSAR) effort using AH-IS COBRA as a baseline. Completed Wire Obstacle Warning System (WOWS) design and started fabrication. Results of the WOWS effort will form the basis for future development of a Wire and Wire-Like Obstacle Detection system. Continued evaluation of multifunction CO2 NOE sensor. Fabricated and tested electronic counter-countermeasures (ECCM) Appliques to the AN/ARC-114 radio. Completed aircraft noise measurements baseline effort. Initiated acceptance testing of integrated control display unit. Started design and fabrication of the Radio Magnetic Indicator/Horizontal Situation Indicator. Conducted user evaluation of Very Lightweight Air Traffic Management Equipment (VLATME). Evaluated Beacon Collision Avoidance System (BCAS) for possible application to tactical air traffic control. Manpack size tactical landing system was tested to evaluate feasibility. Analyzed impact of update frequency and heading error on navigational accuracy, and defined approaches to improve Doppler low-speed accuracy and obtain helicopter-adapted precise attitude/heading reference system (AHRS). Updated in-house facility to enable hybridizing of Doppler with Global Positioning System (GPS), Joint Tactical Information Distribution System (JTIDS) and attitude heading reference system.

2. FY 1979 Program: Continue development of Army Digital Avionics System (ADAS). Continue night navigation and pilotage effort. Complete Avionics System Architecture II (AVSAR II) effort. Award contract for investigation of long range communications needs. Install and test the Wire Obstacle Warning System (WOWS), which is based on charge coupled device technology. Initiate program for a flyable exploratory development model of CO2 nap-of-the-earth (NOE) multifunctional sensor. Initiate effort on electronic master monitor advisory display. Investigate advanced display techniques. Initiate investigation of NOE and SIGINT (signal intelligence) mission navigation system analysis and synthesis. Formulate self-contained/hybrid navigation system architecture using current/anticipated Army attitude, heading, velocity, and positioning sensors and subsystems. Specify requirements for in-house navigation testing instrumentation update. Contract for development of prototype advanced attitude/heading reference. Continue Doppler low-speed accuracy improvement. Model Doppler hybrid navigation systems on hybrid navigation computer support system. Evaluate flight test data on manpack landing ground set. Enhance Very Lightweight Air Traffic Management Equipment (VLATME) hardware and define helicopter terminal area system.



Program Element: #6.22.02.A

DDO Mission Area: #125 - Command and Control

Title: Aircraft Avionics Technology  
Budget Activity: #1 - Technology Base

3. FY 1980 Planned Program: Fabricate and test integrated control/display hardware for System Testbed for Avionics Research (STAR) and initiate effort to integrate navigation map display function of night navigation pilotage system. Provide engineering support to aircraft developers in synthesis of avionics system architectures. Continue development of airborne Single Channel Ground and Airborne Radio System (SINGARS) antenna. Continue development of multifunction CO2 nap-of-the-earth-sensor system, addressing hardware/software for interface with display and pilot. Integrate solid-state symbol generator and display into electronic master monitor advisory display. Reduce velocity bias in order to halve doppler low-speed error rate, assess prototype advanced attitude/heading reference for helicopters, and start van test of Doppler - Joint Tactical Information Distribution System (JTIDS) hybrid navigation. Continue low visibility breakout task in support of landing technology by simulating the low visibility instrument-to-visual transition problem. Perform experiments with helicopter terminal area simulation facility, with conflict prediction capability. Assess utility of Position Location/Reporting System (PLRS) or JTIDS for tactical air traffic control. 38 professionals and 8 support personnel are involved in FY 1980.
4. FY 1981 Planned Program: Complete Advance Digital Avionics System (ADAS) development. Integrate ADAS hardware into digital hot bench, and transition into System Testbed for Avionics Research (STAR). Award contract for advanced communications system architecture analysis. Flight test Multifunction CO2 NOE sensor system. Initiate new effort for hybrid multispectral airborne sensor investigation. Evaluate feasibility model of electronic master monitor advisory display system, and initiate user-developer letter of agreement. Continue advanced display techniques effort with emphasis on solid-state techniques. Continue navigation analysis. Procure updated in-house navigation test instrumentation. Complete Doppler/Joint Tactical Information Distribution System (JTIDS) hybrid navigation van tests. Start development of solid-state attitude/heading reference specifically to suit Nap-of-the-Earth (NOE) environment. Conduct low visibility breakout flight tests, under instrument meteorological conditions, to form basis for helicopter decelerating steep approach and landing. Let contract for self-contained landing system design plans. Start development of multi-modal air traffic management system using Very Lightweight Air Traffic Management Equipment (VLATME) and Beacon Collision Avoidance System (BCAS) technology. 50 professionals and 9 support personnel are involved in FY 1981.
5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.22.09.A

DoD Mission Area: #142 - Aeronautical Vehicle Technology

Title: Aeronautical Technology  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	14246	15659	17183	19932	Continuing	Not Applicable
AH76-A	Aerodynamics	1528	2918	2325	2440	Continuing	Not Applicable
AH76-B	Structures	2675	2939	2945	3080	Continuing	Not Applicable
AH76-C	Propulsion	2900	2727	3085	3040	Continuing	Not Applicable
AH76-D	Reliability & Maintainability	1259	1337	1768	2150	Continuing	Not Applicable
AH76-E	Safety & Survivability	1580	1959	2365	3190	Continuing	Not Applicable
AH76-F	Mission Support	528	703	915	1195	Continuing	Not Applicable
AH76-G	Aircraft Systems Synthesis	1601	1577	1300	1367	Continuing	Not Applicable
AH76-H	Aircraft Subsystems	790	508	435	420	Continuing	Not Applicable
AH76-K	R&D Flight Simulation	1224	640	1520	2420	Continuing	Not Applicable
AH76-M	Man-Machine Integration	161	351	525	630	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program develops and provides the aeronautical technology base required to permit Army aviation to gain a technology advantage to maintain and sustain the operational effectiveness and mission capability of future Army aviation systems integral to the conduct of land battle. Technical areas included are as indicated above.

C. BASIS FOR FY 1980 RDTE REQUEST: The FY 1980 program provides for the continuing development of the aeronautical technology base with particular emphasis directed toward filling technological voids or deficiencies in the areas of rotor flow field, dynamic stall, helicopter drag, rotor/fuselage interaction, ground proximity effects, dynamics of advanced rotors, vibration reduction, stability, control, handling qualities, design criteria, advanced structural materials (composites) for rotors and airframes, and small gas turbine engine components. Additional areas of effort include development of diagnostic-condition monitoring capability; reduction of visual, acoustic, radar and infrared signatures; development of high energy laser protection concepts; improved ballistic tolerance and crashworthiness; development of day/night terrain flying capability for tactical and cargo transport missions; development of adverse weather mission capability including helicopter ice protection; development of helicopter ground movement system; and development of R&D simulators with analytical/analysis capability.

Program Element: #6.22.09.A  
DoD Mission Area: #142 - Aeronautical Vehicle Technology

Title: Aeronautical Technology  
Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

NOTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
	15344	15659	17371	Continuing	Not Applicable

Current submission for FY 1980 (\$17,183,000) represents a reduction of \$188K. This change is the result of minor revisions and reprogramming within each of the technological areas. The decrease in FY78 (\$14,246,000 vs \$15,344,000) reflects service reprogramming required to support higher priority research programs within the technology base.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.22.09.A  
DoD Mission Area: #142 - Aeronautical Vehicle Technology

Title: Aeronautical Technology  
Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** The purpose of this program is to provide a sound technological base for advanced and engineering development programs by developing and providing the essential aeronautical technologies required for improvements in the operational effectiveness and mission capability of Army aviation systems so that a technology advantage can be maintained. Areas of investigation within the technology disciplines consist of the following: fluid mechanics, dynamics, flight control, acoustics, design criteria, weight prediction, material engineering, internal/external loads, fatigue and fracture mechanics, structural concepts, small air flow gas turbines including aerothermodynamics and controls, engine accessories, thrust producers, high-temperature materials, mechanical drive systems, diagnostics and prognostics, maintenance and support, survivability through reduced detectability and aircraft and aircrew protection, flight safety, cargo handling systems, ground support equipments, secondary power systems, environmental control systems, flight simulation, and aviation human engineering. The overall objective is to develop these technologies for application to all Army aircraft systems of the future, including the Advanced Scout Helicopter, the Advanced Attack Helicopter, the UH-60A BLACK HAWK Helicopter, the CH-47 Medium Lift Helicopter, and other product improvement programs.

**G. RELATED ACTIVITIES:** Related programs are performed by the National Aeronautics and Space Administration (NASA), Navy, Air Force, and Department of Transportation. Coordination to eliminate unnecessary duplication is accomplished by: joint program reviews, exchange of program data sheets, research and technology resumes, technical reports; interservice liaison, attendance at scientific meetings and conferences; and joint participation in The Technical Cooperation Program, NASA Research and Technology Committees, and the North Atlantic Treaty Organization (NATO) Advisory Group on Aerospace Research and Development. This program is included in the Tri-Service Aeronautical Vehicle, Structures and Aircraft Propulsion Technology Coordinating Papers. Efforts under this program lead into Advanced Development under Program Elements 6.32.01.A, Aircraft Power Plants and Propulsion; 6.37.11.A, Aircraft Electronic Warfare Self-Protection Equipment; 6.32.09.A, Air Mobility Support; 6.32.11.A, Rotary Wing Controls, Rotors, Structures; and 6.32.12.A, Tilt Rotor Research Aircraft, as well as aircraft systems development.

**H. WORK PERFORMED BY:** The in-house portion of this program is accomplished at the US Army Research and Technology Laboratories, Moffett Field, CA; through the Aeromechanics Laboratory, Moffett Field, CA; Applied Technology Laboratory, Fort Eustis, VA; Structures Laboratory, Langley Research Center, VA; and Propulsion Laboratory, Lewis Research Center, OH. For FY 80, forty-eight percent, or approximately eight million dollars, of the budget for this program is contracted. The top five contractors are Boeing Vertol Company, Philadelphia, PA; Sikorsky Aircraft, Stratford, CT; Pratt and Whitney Aircraft, West Palm Beach, FL; Bell Helicopter Textron, Fort Worth, TX; AResearch Manufacturing Company, Torrance, CA. At least twelve other contractors will share in this program. Many contracts are still open to be awarded on a competitive basis.

**I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

1. FY 1978 and Prior Accomplishments: A helicopter hub/pylon drag analysis and testing program was initiated. A circulation control tail boom mounted on an OH-6A helicopter and a high energy rotor on an OH-58 helicopter were tested. Full-scale whirl tower and flight tests of a UH-1 rotor with Ogee tips and flight tests of three advanced rotor blade profiles on an AH-1G were

Program Element: #6,22,09,A

Sub Mission Area: #142 - Aeronautical Vehicle Technology

Title: Aeronautical Technology  
Budget Activity: #1 - Technology Base

completed. Wind tunnel full-scale tests of a Sikorsky S-76 research rotor and a full-scale multicyclic controllable twist rotor were conducted. A generic helicopter simulation math model was developed and two simulation experiments for terrain flying were conducted. Visual, motion, and simulation systems requirements for the Aviation Research and Development Command R&D simulator were developed. An advanced engine inlet air particle scavenger system demonstrated five times the life of previous scavenger systems in an erosive sand and dust environment. This success led to the use of a similar system on one of the two 800 shaft horsepower advanced technology demonstrator engine designs. Several high-speed (20 thousand revolutions per minute), 1500 horsepower, overrunning (free wheeling) clutch designs for helicopter drive systems were developed and successfully tested. These clutch designs provide the potential for significant weight and cost reduction on operational aircraft. Tactile display devices for reduction of pilot workload were developed and tested. Damaged rotor blade life estimation method was developed. Super-hard windscreen coatings and elastomeric bearing programs were developed. Fast repair techniques for metal rotor blades were demonstrated. An oil debris analysis program was improved. Technology for reducing radar signature of helicopter rotor blades was developed. The Autorotation Analysis Program has been completed. Tests of the vee-tail were completed and indicated a need for greater tail volume. Tests on the circulation control tailboom indicated only 2/3 of the predicted capability. The ability to accurately reproduce in-flight noise patterns in the Vertical/Short Take-Off and Landing (V/STOL) tunnel was demonstrated. Damage levels and blade life after ballistic damage have been accurately predicted and will be used to develop a damage guideline. A math model to analyze spline induced nonsynchronous whirl has been completed. The logic model (LOGMOD) concept of fault isolation has demonstrated almost 100% accuracy on a test using the M-28 turret systems (AH-1G). An oil filtering system has demonstrated its ability to significantly reduce bearing and gear and extend component life. Baseline vulnerability estimates have been developed for all current and most developmental aircraft.

2. FY 1979 Program: Programs to validate the lifting surface theory hover analysis, to improve loads analysis, and to improve rotorcraft wake analysis will be initiated. A study to identify methods and devices for improving autorotation and maneuver capability will be initiated. The hub/pylon drag tests will be completed. Wind tunnel studies of main rotor/tail rotor flow interactions, rotor/fuselage/empennage optimization, and engine exhaust gas reingestion will be initiated. Design of the R&D simulator (Phase I) visual system and motion system will be initiated and simulation system studies will continue. Design, formulation, and demonstration of second generation comprehensive helicopter analysis system will be undertaken. Fabrication and mechanical integrity testing of two cooled, radial-flow turbine designs and the design, fabrication, and testing of five diffuser designs for a 10:1 pressure ratio will be completed. External cargo operation technology will continue with initiation of wind tunnel tests of candidate systems. Laboratory and flight testing of promising ice phobic coating materials for main rotor blades will continue. Fabrication of dynamic test hardware for the microwave deicing concept will be initiated. Man-machine integration efforts will be continued in the areas of aircrew workload, flight simulation, information transfer, and man-machine dynamics. Programs to investigate active rotor loads control and composite fuselage fabrication will be initiated. Rotor dynamic testing, vibration reduction, rotor mast/hub restraint design criteria, aero-elastically conformable rotor systems study and structural integrity modernization will continue. Hub face vibration analysis studies will be completed. The capabilities of the Logic Model Test Set will be evaluated on AH-1 aircraft.

Program Element: #6.22.09.A

DoD Mission Area: #142 - Aeronautical Vehicle Technology

Title: Aeronautical Technology

Budget Activity: #J - Technology Base

3. FY 1980 Planned Program: Investigation of main rotor/tail rotor interaction will begin and investigation of exhaust gas re-ingestion will continue. A full-scale demonstration of an improved hub and pylon configuration will be initiated. The Improved Structural Integrity Recording System (SIRS) will be adapted to the UH-60A. Results of wind tunnel tests of two aero-elastic conformable rotors and the criteria for crashworthy helicopter landing gear will be published. The Hi-Temperature Radial Turbine engine program will be completed. Composite material repair methods will be developed and oil wetted concepts will be applied to new components. Full-scale composite tailbooms will be flight tested. Technical demonstration for loading/restraint and gondola systems will be conducted and the auto loading and static electricity discharge systems will be fabricated. The hydraulic system improvement program will be completed and the electrical system upgrade program will continue. The executive system for the Second Generation Compressive Helicopter Analysis System (2GCHAS) will be initiated. Modification of the Vertical Motion Simulator (VMS) cab and fixed-base station will begin. Flightworthy tactical display will be integrated to permit simulator evaluations of aircraft concepts operating in tactical situations. Personnel involved for this program element include 177 professionals and 147 support personnel.
4. FY 1981 Planned Program: Increased emphasis in technical areas A, B, and C (aerodynamics, structures, and propulsion) are planned. Specific efforts are: Continued tests of advanced rotor/airfoil combinations and full-scale low drag hub and pylon. The SIRS will be flight tested on the UH-60A and a six degree of freedom isolation device will be fabricated. Initiatives in the supporting technical areas include completion of the advanced electric starter and adaptive fuel control programs. Superhard rotor blade edge coatings and oil wetted components will be tested on the AH-1 and CH-47. High-survivability flight components and crashworthy landing gear will be evaluated. The development of external cargo, automatic loading/restraint and ground support systems will continue. Tunnel tests of the microwave ice protection system will begin and efforts to develop advanced hydraulic servo seals will be initiated. Preliminary design for the visual system for the R&D simulator will be completed and functional modules of Phase 1 of the 2GCHAS will be integrated. Efforts will continue to quantify aircrew workload, to include data recording and scoring.

5. Program to Completion: This is a continuing program.



FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.22.10.A

Title: Airdrop Technology

DoD Mission Area: #154 - Mobility and Logistics Technology

Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
	<u>TOTAL FOR PROGRAM ELEMENT</u>	<u>905</u>	<u>1208</u>	<u>1327</u>	<u>1599</u>	<u>Continuing</u>	<u>Not Applicable</u>
0283	Airdrop Technology	905	1208	1327	1599	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supports basic airdrop technology, evaluates the feasibility and practicability of new concepts which have potential for increasing the mission capabilities of airdrop operations and/or the potential for reducing the costs in acquisition, use, and maintenance, of airdrop systems and equipment. The airdrop research, development, test and evaluation (RDTE) program, which includes parachute technology, supports all of the Services, and is necessary for the employment and resupply of airborne and conventional units. Airdrop projects are included in the Army US Army Training and Doctrine Command (TRADOC) critical category priority list, the Science and Technology Guide (STOG), Capabilities Categories (CAPCAT) 79-5 and fall under direct combat support.

C. BASIS FOR FY 1980 RDTE REQUEST: Continue exploratory development efforts in the areas of Gliding Decelerator Technology, Rigging Technology, High Level Airdrop Technology, Free Drop Technology, High Speed Airdrop Technology, Advanced Airdrop Technology, and Design Criteria for Airdrop Aircraft. Initiate work in Airdrop Simulation.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
	1155	1208	1888	Continuing	Not Applicable

The decrease in the 1980 estimate from FY79 to FY80 reflects a decision to reduce fluctuations created by inconsistent yearly allocations and airdrop programs (6.2, 6.3, and 6.4) allocations. This should insure a better managed program.

E. OTHER APPROPRIATION FUNDS: Not applicable.

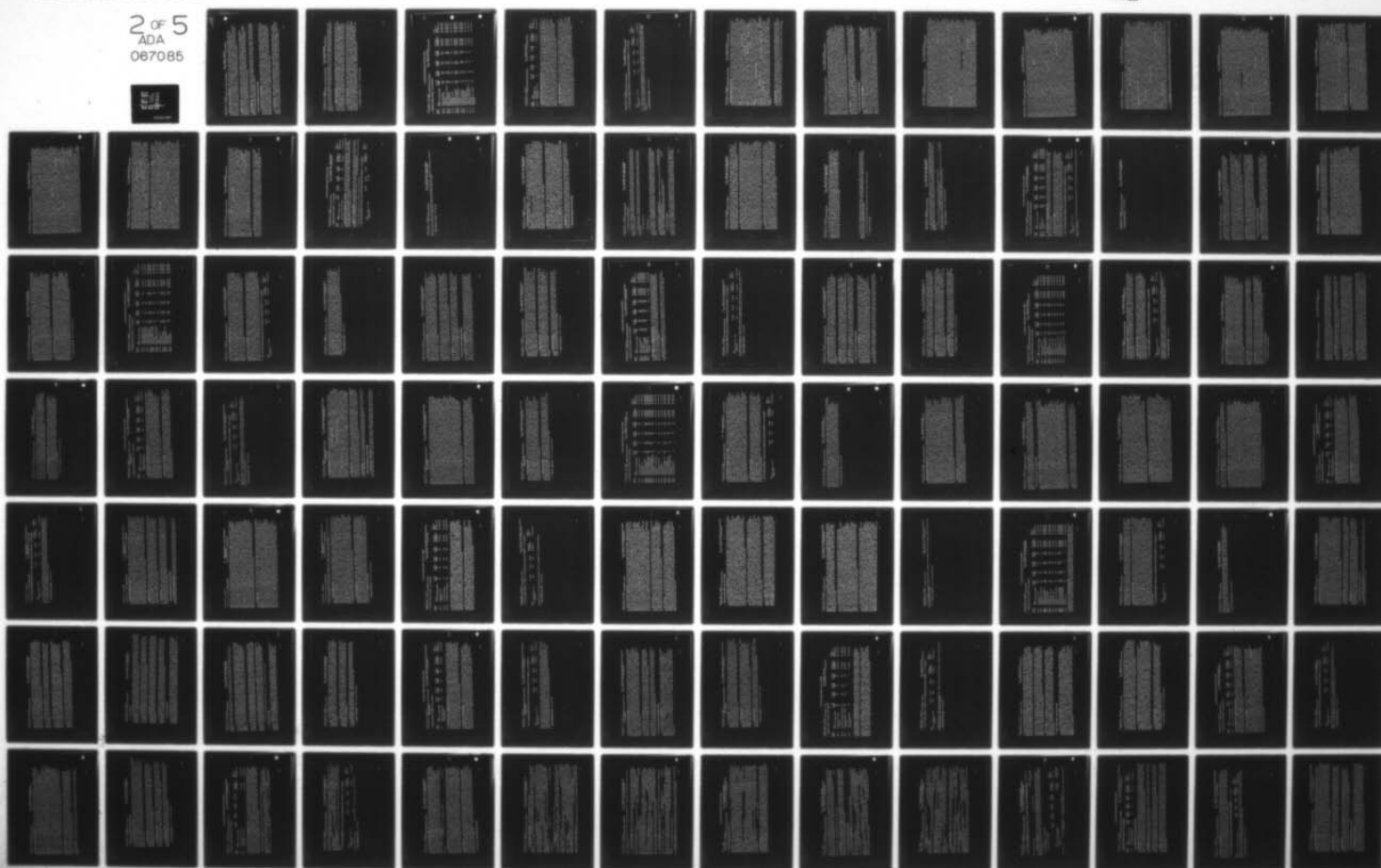
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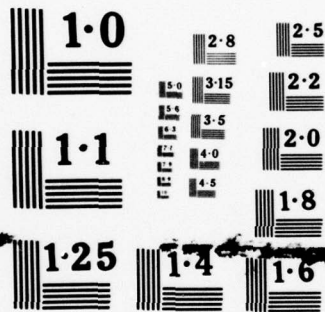
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Program Element: #6.22.10.A

DOD Mission Area: #154 - Mobility and Logistics Technology

Title: Airdrop Technology

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: Major areas of effort are: the validation of computer modeling of high glide decelerators; defining and testing feasible airdrop guidance and control systems; exploring airdrop feasibility at higher aircraft drop speeds and airdrop altitudes; developing design criteria for airdrop aircraft; developing new rigging concepts for cargo loads; and continuation of the development of advanced airdrop technology. Objectives are to increase airdrop operational capabilities at all altitudes and in all weather and geographical environments, increase airdrop accuracy, reduce drop zone dispersion, provide the technology base for advanced airdrop systems, eliminate technical barriers hindering attainment of new airdrop capabilities, and reduce the costs of developing airdrop components and systems.

G. RELATED ACTIVITIES: Program Elements 6.32.18.A.B, Airdrop Equipment and Technology, and 6.42.18.A, Airdrop Equipment Development; Joint Technical Coordinating Group/Airdrop; North Atlantic Treaty Organization, and Air Standardization Coordinating Committee (ASCC/MP44) Standardization Agreements; Mutual Weapons Data Exchange Agreements with France and Germany. International and interservice agreements and boards are used to exchange information on gains in airdrop technology, to avoid duplication of effort through joint and combined efforts, and to promote and attain the objectives of US Rationalization, Standardization and Interoperability (RSI) policies and programs.

H. WORK PERFORMED BY: Raytheon Corporation, Boston, MA; Magnavox Corporation, Fort Wayne, IN; Irving of Canada, Canada; Pioneer Parachute Company, Manchester, CT; ParaFlite Incorporated, Pennsauken, NJ; Bertin & Cie, Plaisier, France; University of Maryland, College Park, MD; Convair Division of General Dynamics, San Diego, CA; US Army Yuma Proving Ground, Yuma, AZ; and US Army Natick Research and Development Command (NARADCOM), Natick, MA.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: A computer simulation program for the flight performance of gliding decelerators was developed and studies initiated to validate the computer model through flight testing. Contracted studies to assess state-of-the-art in guidance and control hardware for gliding decelerators were completed. Simplified rigging procedures for use of energy dissipater materials were developed. Prototype was selected to overcome pitch instability of platform loads at high altitudes. Contract was let to identify operationally feasible concepts for airdrop ground assembly aids. Selected canopy design concept for free-fall maneuverable reserve parachute and procured test quantities. Identified and conducted tests of new materials for three-gallon free-drop water container. Participated in airdrop tests from Air Force Advanced Medium STOL Transport (AMST) Aircraft (C-14, C-15) and C-141B aircraft; prepared Army airdrop evaluation reports.
2. FY 1979 Program: Complete validation of gliding decelerator computer modeling through actual flight tests. Evaluate alternative guidance and control hardware for gliding decelerators. Award contract for the design and test of gliding decelerator(s). Continue studies on rigging concepts for integrating parachutist with accompanying equipment and weapons. Complete flight testing of pitch stability prototype for High Level Platform Airdrop System. Complete, under contract, development of near term concepts for airdrop ground assembly aids. Initiate a program definition study for developing techniques, equipment and

Program Element: #6.22.10.A

DoD Mission Area: #154 - Mobility and Logistics Technology

Title: Airdrop Technology

Budget Activity: #1 - Technology Base

development and testing of Air Force developmental aircraft (C-14, C-15, C-141B). Complete testing of new materials for three-gallon free-drop water container. Procure and evaluate French balloon skirt as potential airdrop platform energy dissipater system.

3. FY 1980 Planned Program: Procure prototype guidance and control subsystem for gliding decelerator(s) and initiate testing. Complete design and fabrication of gliding decelerator(s). Complete flight testing of prototype components to solve pitch instability problem of High Level Airdrop Platform System. Continue studies on airdrop at high aircraft release speeds. In accordance with plans developed in FY 1979, initiate efforts to develop laboratory simulation techniques and equipment for airdrop parameters. Procure selected hardware and evaluate as potential ground assembly aids. Resume study efforts to develop technology base for the design of free-drop resupply airdrop systems. Complete feasibility tests of French balloon skirt as potential "soft landing" alternative. Eleven professional and nine support personnel are involved in the program.

4. FY 1981 Planned Program: Continue testing of gliding decelerator(s) with selected guidance and control system(s); identify and select areas of effort in high level airdrop platform task related to data base of wind information, new recovery systems, combined extraction and stabilization parachute and special hardware. Initiate studies of high level airdrop of personnel to identify problems and alternate concepts. Continue efforts to provide data base for design of free-drop resupply airdrop systems; continue exploration of new airdrop concepts, the development of advance airdrop technology, development of new concepts to reduce complexity and cost of rigging airdrop loads, development of airdrop laboratory simulations, and development of design criteria for developmental airdrop aircraft. Continue investigation of specific "soft landing" airdrop configurations for free-drop. Award contract for feasibility study of High Speed Airdrop System.

5. Program to Completion: This is a continuing program.

FY 1980 RITE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: 6.23.03.A

DoD Mission Area: 7144 - Guided Missiles and Rockets

Title: Missile Technology

Budget Activity: 71 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	<u>TOTAL FOR PROGRAM ELEMENT</u>	<u>23810</u>	<u>28726</u>	<u>29350</u>	<u>32823</u>		<u>Not Applicable</u>
A214-01	Sensors Technology	4053	5762	4875	5493	Continuing	Not Applicable
A214-02	Guidance and Control Technology	3188	3925	4050	4543	Continuing	Not Applicable
A214-03	Terminal Guidance Technology	3588	3460	4226	4580	Continuing	Not Applicable
A214-04	Digital Technology	255	550	1329	1500	Continuing	Not Applicable
A214-05	Simulation Research Technology	2152	2600	2588	3003	Continuing	Not Applicable
A214-06	Experimental Systems Technology	1764	2300	2400	2456	Continuing	Not Applicable
A214-07	Aerodynamics Technology	2339	3050	2815	3323	Continuing	Not Applicable
A214-08	Propulsion Technology	2287	2950	3025	3458	Continuing	Not Applicable
A214-09	Ground Support Equipment Technology	851	1350	1563	1566	Continuing	Not Applicable
A214-10	Structures Technology	943	950	950	1159	Continuing	Not Applicable
A214-11	Technology Integration	0	469	469	500	Continuing	Not Applicable
A214-12	Systems Concepts and Analysis Technology	300	330	330	418	Continuing	Not Applicable
A214-13	Sensors and Control Technology for Guided Projectiles	380	400	400	500	Continuing	Not Applicable
A214-14	Hybrid Microelectronics Technology	237	330	330	324	Continuing	Not Applicable
A214-15	High Energy Laser Research Technology	400	300	0	0	Continuing	Not Applicable



Program Element: #6.23.03.A

DoD Mission Area: #144 - Guided Missiles and Rockets

Title: Missile Technology

Budget Activity: #1 - Technology Base

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Continuing	Total	
							Estimated Costs	Not Applicable
A214-16	Free Flight Rocket Technology	1013	0	0	0	Continuing	Not Applicable	
A214-17	Nuclear Weapon Effects Technology	60	0	0	0	Continuing	Not Applicable	

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program includes virtually all of the exploratory development work conducted by the US Army Missile Research and Development Command to provide the technical base for future Army tactical missile systems and evolutionary or modular improvements to fielded systems. It is responsive to the operational needs identified on an annual basis by the user proponent in the form of science and technology objectives, and encompasses work in applied research, laboratory hardware development, and limited experimental testing. The principal thrust is in the areas Air Defense, Fire Support and Close Combat. The Close Combat area addresses both antitank and assault/military operations in urban terrain (MUNT) type requirements. This program helps protect the US technological lead in tactical missiles and rockets and satisfies a critical Army requirement to: (1) maintain a strong in-house technical arm that can be a smart buyer and work in a cooperative way with industry, the military user and academic community to provide the best missile/rocket hardware and technology at least practical cost; (2) provide for research and development in those areas where there is little or no incentive for industry because of the lack of a major commercial market; (3) provide for technical options and viable alternatives that preclude unwarranted sole source procurements; and (4) provide a quick response capability in time of crisis.

C. BASIS FOR FY 1980 ROUTE REQUEST: Request provides for continuation of exploratory development work in missiles and rockets to enhance Army capabilities in Air Defense, Fire Support and Close Combat. Major efforts include: complete the design of a track-while-scan quiet radar; establish technology base for a lightweight air defense suppression missile; complete demonstration of a simplified inertial guidance scheme; develop a helicopter-launched, dual mode seeker for antiarmor fire and forget and air defense suppression missile; complete exploratory development on a fiber-optics guided missile concept; complete exploratory development on a kinetic energy penetrator antiarmor concept; transfer to advanced development a rifleman's assault weapon concept and a special hard target assault weapon concept; continue exploitation of promising rocket motor concepts and techniques for reducing propellant signature and rocket motor costs; emphasize the development of various seekers/sensors covering the acoustical, radio frequency, millimeter wave, and infrared, that provide improved capability in adverse environments; continue the development of electro-optical sensors; advance methods for improved structural analysis and develop design techniques for composite structures; and develop launching techniques for firing from enclosures.

Program Element: #6.23.03.A  
DoD Mission Area: #144 - Guided Missiles and Rockets

Title: Missile Technology  
Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Costs	Not Applicable
	26276	30126	27949			

The FY 1978 decrease reflects in-house reprogramming to provide for unanticipated higher priority requirements arising during the year. The FY 1979 decrease reflects the Congressionally approved program versus the amount requested. The FY 1980 increase reflects the addition of funds for technology efforts to support the development of an air defense suppression missile (ADSM) capability.

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.23.03.A

DoD Mission Area: #144 - Guided Missiles and Rockets

Title: Missile Technology

Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** The broad objectives of the program are to: (1) develop guidance and control and terminal homing systems having multimode and fire and forget characteristics, reduced vulnerability to antiradiation missiles, and the capability for operation in adverse weather, countermeasure environments; (2) develop minimum signature propulsion systems and low cost missile/rocket components with improved service life; (3) reduce development cost through simulation/tactical software; (4) reduce risk in new system developments. These objectives involve most of the scientific and engineering disciplines related to missile and rocket development. The program consists of 17 technology areas (corresponding to the project numbers listed in paragraph A), 14 of which are currently active. Work areas contained within the technology areas follow:

Sensors - advanced radar; acoustic/infrared sensing and signal processing; optical command and beamrider; millimeter guidance; infrared homing; radio frequency (RF) guidance; sensor design and signal processing. Guidance and Control - advanced guidance systems; modular guidance; automatic tracking and integrated fire control; inertial components; laser designer/weapon system simulation; advanced analysis for future missile guidance and control. Terminal Guidance - guidance system integration and verification; optical homing; system application of sensors; laser guidance and designators; terminal homing measurements. Digital - missile tactical software; missile imbedded computer hardware. Simulation Research - RF simulation technology; infrared/electro-optical simulation technology; hybrid computer technology; millimeter simulation. Experimental Systems - infantry weapons, small craft weaponization; aircraft weapons; artillery systems. Aerodynamics - flow interference phenomena affecting direct fire missiles; fiber-optics guidance (vehicle demonstration); submissile aeroballistics; advanced configuration design for air defense missiles; verification of hypervelocity antiarmor concepts; dynamically aimed free-flight rockets. Propulsion - low exhaust signature propulsion; cost reduction; advanced concepts (for example, reduced impulse noise technology for advanced shoulder fired weapons). Ground Support Equipment - launching techniques; airborne support equipment technology (including anti-icing techniques); loading and transport technology; launcher control systems; auxiliary systems technology (includes test equipment). Structures - missile system structures; structures analysis; environmental effects (including advanced ablative radomes). Technology Integration - technology planning, independent research and development. Systems Concepts and Analysis - user requirements analysis; new concept generation. Sensors and Control for Guided Projectiles - indirect fire; direct fire. Hybrid Microelectronics has a single work area covering large scale hybrids, flexible, thin film devices, and thermal modeling and analysis. High energy laser research technology will be funded under a separate single program element funding line in FY 1980. Free flight rocket technology, as a separate technology area, was terminated at the end of FY 1978 due to user deemphasis on this technology following the introduction of the General Support Rocket System (GSRS) program. Essential free flight rocket technology is still being pursued within the propulsion, aerodynamics and ground support equipment technology areas. Nuclear weapon effects technology has been merged into a single program per direction of the Office, Secretary of Defense.

**G. RELATED ACTIVITIES:** Efforts in this program relate closely to science and technology programs conducted by the Defense Advanced Research Projects Agency, the US Navy, the US Air Force, the National Aeronautics and Space Administration (NASA), as well as other programs within the Army. Unwarranted duplication is precluded by active participation by laboratory personnel in interagency working groups, liaison visits to agencies/activities involved in missile related science and technology work, the free exchange of information among agencies via the Defense Documentation Center and the National Technical Information



Program Element: 16.21.01.A

DoD Mission Area: 144 - Guided Missiles and Rockets

Title: Missile Technology

Budget Activity: 1 - Technology Base

Service, and deliberate structuring of the program to concentrate on the Army's unique needs in tactical missiles. Where potential areas of unwarranted duplication have been identified, appropriate agreements have been affected with the command/agency concerned. Examples of current agreements include: Memorandum of Agreement with the Ballistic Missile Defense Advanced Technology Center, Huntsville, AL, covering nonnuclear intercept technology in the areas of propulsion, guidance and control, sensors, seekers, and optical data processing; Memorandum of Agreement with the US Air Force Armament Laboratory, Eglin Air Force Base, FL, covering efforts in infrared and millimeter wave seeker technology as they relate to precision guided munitions; Memorandum of Agreement among Army Research and Development Commands delineating areas of responsibility for fire control developments; Memorandum of Agreement with the US Army Armament Research and Development covering the development of sensors and controls for guided projectiles. Membership exists in working groups of the Joint Services Guidance and Control Committee (JSGCC), The Joint (Tri-Service) Technical Coordinating Group for Munitions Development (missiles and rockets), Joint Army/Navy/National Aeronautics and Space Administration (NASA)/Air Force committees, and North Atlantic Treaty Organization Panels. Under the JSGCC, for example, a tri-service working group on terminally guided submunitions has been active for more than a year, and three new working groups covering a millimeter wave guidance, active/passive radio frequency guidance, and midcourse guidance have been recently formed. These initiatives have proved effective in eliminating unwarranted duplication.

**H. WORK PERFORMED BY:** The US Army Missile Research and Development Command (HIRADCOM), Redstone Arsenal, AL, has primary responsibility for execution of this program. Approximately 48 percent of the dollars are contracted out to more than 50 contractors and universities. Major contractors include Hughes Aircraft Corporation, Fullerton, CA, Battelle Memorial Institute, Columbus, OH; Texas Instruments Incorporated, Dallas, TX; and Martin-Marietta, Orlando, FL. Universities include Georgia Institute of Technology, Atlanta, GA; Auburn University, Auburn, AL; University of Alabama, Huntsville, AL; University of Alabama, Tuscaloosa, AL; Tennessee Technological University, Cookeville, TN.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: A breakdown of key accomplishments in each of the technology areas follows: Sensors - Explored and developed through breadboard/brassboard/test bed the following seeker/sensors: (1) common aperture multispectrum seeker for possible application to an air defense suppression missile; (2) multi-environment active radio frequency seeker for possible application to a variety of antiarmor systems such as the HELLFIRE helicopter-borne missile system, the CORPERHEAD artillery projectile and emerging advanced antitank missile system concepts; (3) infrared imaging seeker for possible HELLFIRE application; (4) two-color infrared (IR) seeker for indirect fire, which is a candidate in the Assault Breaker demonstration for defeat of second echelon armor; (5) an advanced signal processor for the POST ROSETTE seeker prior to transition into engineering development under the STINGER air defense missile system program; (6) two millimeter wave seekers in the range for a variety of possible indirect and direct fire applications; (7) radio frequency active seeker for possible application to small diameter (five to eight inch) air defense missiles; continued accelerated development of integrated focal plane array seekers for application to next generation systems employing imaging seekers; demonstrated a gallium arsenide beamrider guidance concept to include 38 missile flights (this concept could have application to an advanced medium antiarmor

Program Element: #6.23.03.A

DoD Mission Area: #144 - Guided Missiles and Rockets

Title: Missile Technology

Budget Activity: #1 - Technology Base

missile system concept or for air defense); completed the design for a low sidelobe, agile beam antenna aimed at reducing the vulnerability of air defense systems to the antiradiation missile threat and began hardware fabrication; demonstrated algorithms for seeker autonomous target acquisition and automatic cueing; defined the critical requirements of a reduced signature radar and began experiments to quantify its vulnerability using a modified HAWK low power illuminator; designed a signal analysis van for support of reduced signature radar field tests; demonstrated adaptive gate centroid/correlation imaging tracker concept using high speed microprocessor technology; demonstrated a forward looking Infrared (FLIR) video track link and investigated a carbon dioxide (CO<sub>2</sub>) command line of sight track link for possible application to the emerging advanced antiarmor missile system concepts; tested the CO<sub>2</sub> beamrider at extended ranges and in tactical smokes and aerosols. Guidance and Control - Developed and tested algorithms and microprocessors for a low cost digital autopilot for small missile application; designed and tested the necessary flight hardware for a simplified inertial guidance demonstration (SIG-D) to investigate the areas of technical risk associated with a low cost, surface-to-surface missile, utilizing a strapdown ring laser gyro inertial guidance system (this concept could lead to the next generation surface-to-surface missile system); designed and developed a digital automatic handoff correlator (television-to-television) for possible application to the advanced attack and advanced scout helicopters; completed laboratory evaluation of a high performance low cost accelerometer utilizing dry tuned gyro technology aimed at reducing the cost of the next generation surface-to-surface missile system; completed performance evaluation of a precision gyrocompass aimed at reducing the reaction time and improving the accuracy of the next generation surface-to-surface missile system; developed a laser designator/weapon system simulation (LWSS) to determine more uniformly the performance of semiautomatic laser weapon systems. Terminal Guidance - Explored terminal homing applications of solid state imaging devices as a total effort toward achieving an automatic target acquisition capability for possible missile guidance and advanced helicopter applications; initiated development of a generic infrared (IR) weapon system simulation for imaging and nonimaging IR seekers (basic simulation 80 percent complete with limited imagery); developed a long wavelength active laser seeker for possible application to fire and forget terminal homing missiles for use in adverse environmental conditions; developed jointly with the Naval Weapons Center a long wavelength semiautomatic laser guidance system including seeker and designator for potential application to adverse environment terminal homing land combat missiles; determined the radiation scattering characteristics of dust, conducted target signature measurements and measured and modeled atmospheric effects for application to direct and indirect fire missile development programs; conducted target signature measurements in terrain background in IR bands and gigahertz millimeter wave bands to support IR and millimeter wave seeker/sensor concepts. Digital - Developed low cost compiler methodology for tactical missiles; demonstrated effectiveness of higher order language (HOL) for small missile application; selected interim HOL for missile system applications; began definition of Army requirements for establishing a standard tri-Service bus structure for application of distributed microprocessor techniques to a family of Army missiles. Simulation Research - Completed development of hardware and software for the simulation of targets and clutter for active radio frequency seekers; completed design for an improved infrared/ultraviolet (IR/UV) target projector which will provide complex plume and fuselage simulations of advanced IR surface-to-air missile systems; completed a thermal terrain model; completed development of an advanced hybrid operating system for automatic setup and checkout of hybrid computers which will improve simulation efficiency. Experimental Systems - Completed the majority of the exploratory development tasks required for a rifleman's assault weapon and a special hard target assault weapon, which are two candidate concepts for satisfying emerging weapon requirements for military operations in urban terrain;



Program Element: #6.21.03.A

DoD Mission Area: #144 - Guided Missiles and Rockets

Title: Missile Technology

Budget Activity: #1 - Technology Base

completed concept definition for a manportable, true fire and forget antitank weapon for attack of tanks from the top (designated fire and forget antitank system technology or FFAST); evaluated small aircraft requirements for the application of Army missile systems; in response to user request, integrated the STINGER Remote Simulator with the AH-1S and OH-58C helicopters; evaluated the potential of an aerial rocket mine scattering subsystem; developed and performed captive flight tests on an active radio frequency seeker for possible application to surface-to-air missiles; assisted user in preparing a joint mission element need statement for a battlefield interdiction and close air support capability. Aerodynamics - Developed a transonic drag calculation for electro-optical/infrared missile configurations; established helicopter downwash data base for air launch missile simulation; developed methodology for determining plume induced interference for systems typified by the General Support Rocket System (GSRS); awarded contract to Aeronautical Research Associates of Princeton University for initial phase of a tri-service program to produce standardized rocket exhaust plume computer code; established viscous scaling effects for maneuvering missile aerodynamics; completed an engine/plume model for improved signature definition of threat aircraft; completed design and began fabrication of components for a fiber-optics guided missile concept, a possible candidate to fill the advanced heavy antiarmor missile requirement; began investigation of problems associated with submissile aeroballistic dispersion at both subsonic and supersonic velocities for indirect fire artillery systems; established feasibility and completed component tests for a hypervelocity antiarmor concept (designated single penetrator kinetic energy hypervelocity system, SPIKE) - 10 flight rockets fabricated - aimed at providing an alternative to chemical energy antiarmor systems. Propulsion - Completed exploratory development and handed-off to advanced development a minimum smoke motor for the CHAPARRAL air defense missile, a high burn rate propulsion system for the VIPER antitank missile, a reduced smoke motor for the HELIFIRE antiarmor missile, and a hydroxyl terminated polybutadiene (UTPB) propellant for the PERSHING long range, surface-to-surface missile; utilized polymer technology in solving a motor unbond problem for the Improved HAWK air defense missile and the temperature aging problem for the STINGER shoulder launched, air defense missile; demonstrated a high performance, lower cost, double base propellant; improved service life prediction techniques for propellants by verifying thermal loading; investigated techniques to reduce blast noise associated with missile firings from enclosed structures (applicable to military operations in urban terrain). Ground Support Equipment - Developed low cost launcher design and fabrication techniques which have been applied to the surface launched unit fuel air explosive mine clearing system; designed, fabricated and demonstrated on the AH-1C helicopter an airspring vibration isolator for possible application to helicopter-borne weapon systems; developed a mathematical model for selecting combinations of cushioning materials for missile containers; designed and functionally tested in the laboratory magnetic detectors for measurement of malfunctions; investigated low signature launching concepts for firing from enclosures in military operations in urban terrain (a liquid ejection concept was selected for feasibility determination and static firing tests were successfully conducted); began tests on composite container/launchers made from various low cost, commercially available materials; investigated and established requirements for future ground-mobile under-armor tracking mounts; evaluated switching modules for definition of a concept for automatic test equipment. Structures - Incorporated geometric nonlinearities and torsional loading effects in composite structure analysis computer codes and initiated plate buckling code development; developed and tested large filament wound launch tubes and motor cases; identified, through rain and thermal erosion testing, improved structures for radomes applicable to the PERSHING long range, surface-to-surface missile and the PATRIOT air defense missile; completed and published a composites fracture mechanics



Program Element: #6.23.03.A

DoD Mission Area: #144 - Guided Missiles and Rockets

Title: Missile Technology

Budget Activity: #1 - Technology Base

design manual; constructed a realtime, three dimensional, acoustical holography system for experimental structural analysis; designed, fabricated and tested an experimental launch pad container of advanced composites and conventional plastics; investigated techniques for making fiberglass launcher tubes reusable for multiple launchings. Technology Integration - Not applicable. This is a new start in FY 1979. Systems Concepts and Analysis - Performed, on a continuing basis, user requirements analysis to ensure correlation of laboratory plans and system concepts with the Science and Technology Objective Guide and other advanced missile planning documents; supported foreign technology assessments; generated and analyzed new missile system concepts, including an advanced heavy antitank missile system (AHAMS), fire and forget antitank system technology (FFAST), and product improvement proposals for the TOW and DRAGON antitank missile systems; monitored independent research and development activities. (This later task will be incorporated under a new technology area, designated Technology Integration, beginning FY 1979.) Sensors and Control for Guided Projectiles - Completed a high-g materials investigation which was applied in the development of the COPPERHEAD artillery projectile; initiated development of g-hardened sensor components, sensors systems and noninertial roll rate systems for indirect fire application; developed a hot gas generator for improved actuating controls in direct fire applications; modeled mathematically projectile guidance loop components and error sources for infrared signatures associated with direct fire applications; initiated studies on high-g thrusters, actuators, and aerodynamic controls associated with direct fire applications. Hybrid Microelectronics - Completed design, fabrication, and breadboard tests of hybrids for a digital autopilot (discussed also under the guidance and control technology area); developed a thermal characterization model for high density hybrid circuits and published guidelines; developed and demonstrated a computer program and algorithm to do schematic sketching in hybrid design; evaluated large scale hybrids to military specifications and published a report of the results; initiated development of flexible, thin film devices. High Energy Laser Research - Built mobile field test equipment and began measurements of laser induced effects on optical elements and subsystems; installed a closed cycle nuclear pumped laser subsystems (Auburn University facilities/personnel utilized in this effort in addition to in-house resources). This technology area is to be incorporated under a High Energy Laser single program element funding line beginning FY 1980. Free Flight Rockets - Completed a series of 10 thousand pounds and 17 thousand pounds thrust motor firings; completed preliminary design and calculated an error budget of a rocket concept; fabricated and successfully tested through firings a low cost foam launcher; completed a static firing demonstration of a motor incorporating a low cost case. This technology area terminated following FY 1978 as a separate technology area. Essential free flight rocket tasks have been merged into Propulsion, Aerodynamics and Ground Support Equipment Technology areas. Nuclear Weapon Effects - Completed baseline design of an E-Field cable driver; performed susceptibility analysis of E-Beam controlled high energy lasers to ionizing radiation; investigated the effects of radiation on missile electronic components; developed a D-dot probe for measuring electric field intensity associated with the electromagnetic pulse. This technology area was terminated in FY 1978 and merged under a single program per direction of the Office, Secretary of Defense.

2. FY 1979 Program: Anticipated accomplishments by technology area follow: Sensors - Complete fabrication of the low side-lobe agile beam antenna and begin laboratory evaluation; initiate design of a reduced signature, track-while-scan radar; build and

Program Element: #6, 23, 03, A

DoD Mission Area: #144 - Guided Missiles and Rockets

Title: Missile Technology

Budget Activity: #1 - Technology Base

begin outfitting the signal analysis van; expand technology base for acoustic/infrared sensing which appears to be a promising area for passive aircraft target detection; complete validation test of carbon dioxide beamrider concept; demonstrate forward looking infrared video tracker in degraded environments; evaluate millimeter beamrider missile subsystem concepts and hardware; complete evaluation of the two-color indirect fire seeker; complete millimeter wave seeker signal processor design and test for air defense suppression missile application; initiate long wavelength focal plane array seeker development; conduct captive flight tests on the multienvironment active radio frequency seeker; provide sensor technology support for the fiber-optics demonstration program. Guidance and Control - Conduct three flight tests of the simplified inertial guidance demonstration (SIC-D) missile and guidance system; demonstrate digital autopilot flight performance; conduct flight evaluation of the television-to-television automatic target handoff correlation hardware; develop crystal technology for a crystal constained accelerometer; develop a low cost land navigator; validate hardware models and develop a battlefield obscurant scenario model for the laser designator/weapon system simulation. Terminal Guidance - Complete the basic infrared weapon system simulation for imaging sensors and incorporate nonimaging indirect fire infrared (IR) seekers; define the mechanization concept for a laser/IR seeker for potential application to HELLFIRE and COPPERHEAD; perform design studies of antiradiation missile concepts; investigate the capability of long wavelength laser systems in smoke and other field environments; conduct terminal homing measurements and analysis of tank target acquisition and tracking characteristics at dust, and adverse weather on laser, IR, and millimeter wave sensors; determine applicability of ionospheric propagation of high frequency waves to long range missile guidance. Digital - Develop higher order language (HOL) missile system methodology for implementing a DDD standard language; investigate different approaches to missile compiler development utilizing distributed processing techniques; initiate selection and begin development of automated software design methodologies plus tools for missile system software design and analysis; complete definition of a standard bus structure for communication between distributed microprocessors in future Army missile systems and implement into existing in-house designed microprocessor hardware. Simulation Research - Complete interim distributed source generator for simulating complex radio frequency (RF) targets and clutter; fabricate and install improved infrared/ultraviolet target and countermeasure projectors, a raster target projector, and thermal target simulators to enhance simulation capability; design and procure a data acquisition system and parallel design processor to enhance simulation operations and data manipulation. Experimental Systems - Demonstrate warhead for the rifleman's assault weapon (RAW); evaluate RAW characteristics when fired from enclosures; flight test an optimized warhead and a new time delay fuze for the special hard target assault weapon LAW (SHAWL); develop and fabricate brassboard critical components for the fire and forget antitank system technology concept; support air-to-air self-defense operational evaluations of STINGER; develop and test a multimotor powerpack using 2.75-inch rockets, or other candidate rockets, as a mine delivery system; continue development of the hemispheric coverage antenna (HCA) with emphasis on possible technological improvements to enhance performance - this effort directed by the Office, Under Secretary of Defense for Research and Engineering; conduct concept definition phase for field artillery missile system (FAMS). Aerodynamics - Refine experimental techniques for simulating plume interference effects; complete component integration of fiber-optics guidance concept hardware; conduct in-house simulations of various techniques for submissile deployment; complete Phase I single round flight tests of the hypervelocity penetrator antiarmor concept. Propulsion - Demonstrate in static firings a high performance, double base propellant with 10 percent increase in



Program Element: #6.23.03.A

DoD Mission Area: #144 - Guided Missiles and Rockets

Title: Missile Technology

Budget Activity: #1 - Technology Base

performance and transmissivity compared to the TOW flight motor; conduct static firings of low cost, artillery-type rocket motors to verify impulse reproducibility; demonstrate in static firings the performance of the spinning plug nozzle. Ground Support Equipment - Finalize design of low signature launching techniques for applications to military operations in urban terrain; initiate development of aircraft external stores icing protection techniques; complete firings and environmental testing of containers/launchers fabricated from low cost, commercially available materials; develop under-armor ground vehicle tracking station concepts for improving tracking accuracy of antiarmor missile systems and ground laser designators; develop multiple launcher which re-aims between rounds in a ripple; define automatic test equipment concepts. Structures - Test reusable fiber-glass launcher tubes; test commercially available composite structural shapes; improve advanced multidimensional heat transfer analysis methods; test candidate fibers and resins for enhanced performance and reduced costs for high performance missile radomes; develop self-forging fragment structures for application with over-armor guidance techniques. Technology Integration - Evaluate foreign technology programs as required; conduct independent research and development (IR&D) on-site reviews and analyze IR&D programs for potential solutions to critical Army needs; develop FY 1980 technology base plan. Systems Concepts and Analysis - Perform user requirements analysis to ensure correlation of laboratory plans and system concepts with the Science and Technology Objectives Guide and other advanced missile planning documents; provide in-house analysis and definition of optional system approaches to documented weapon requirements. Sensors and Control for Guided Projectiles - Continue to develop and test g-hardened components and systems for indirect fire application; test a g-hardened control force system for direct fire application; develop an infrared scene synthesis model for direct fire application. Hybrid Microelectronics - Correlate leak rates with moisture penetration for hybrids; fabricate flexible thin film transistors; initiate large scale hybrid version of digital autopilot. High Energy Lasers - Measure laser induced effects on complex optical systems, such as infrared seekers; complete closed cycle circulator installation and evaluate acoustic control techniques; assess advantages/disadvantages of pulsed chemical laser (new start in FY 1979); define experimental program for acquisition of data on pulsed chemical laser.

3. FY 1980 Planned Program: Planned accomplishments by technology area follow: Sensors - Complete design of track-while-scan quiet radar; complete signal analysis van and integrate equipment; conduct simulation efforts for acoustic/infrared sensing concept; perform preliminary design of an acoustical terminal homing seeker; initiate carbon dioxide beamrider flight demonstration program; optimize forward looking infrared video tracking technology; initiate development of a prototype millimeter wave guidance system and a target acquisition system operating in millimeter wave region (aimed at improving the adverse weather performance of direct fire and helicopter-borne systems); evaluate performance of focal plane array infrared (IR) seeker; demonstrate automatic target handoff to a small field of view IR seeker; perform sensor design and signal processing applicable to autonomous acquisition and fiber-optics concepts; perform experimental and theoretical investigations into target classification acquisition, and guidance for radio frequency seekers. Guidance and Control - Complete flight test analysis of the simplified inertial guidance demonstration (SIG-D); flight test optimal trajectory control with digital autopilot; perform laboratory and flight evaluation of automatic target handoff correlation hardware; analyze problems associated with adapting automatic target correlation hardware for use with radar and inertial navigators; design an all digital strapdown inertial measuring unit; provide system studies support and extend models for the laser designator/weapon system simulator to infrared and millimeter applications.



Program Element: #6.23.03.A

Guid Mission Area: #144 - Guided Missiles and Rockets

Title: Missile Technology

Budget Activity: #1 - Technology Base

Terminal Guidance - Expand the infrared weapon system simulation (IRWSS) modeling to include smoke and aerosols, update seeker models, and investigate two-color IR modeling; fabricate and test critical components for laser/IR seeker; initiate development of a tactical configuration long wavelength active laser seeker; conduct adverse environment terminal homing measurements program to assess sensors for direct fire guidance. A new task recently added to this technology area concerns the development of technology for an air defense suppression missile development. A total of \$1.5 million has been allocated under this technology area for this work which will be directed toward the following: development of small passive superheterodyne seekers (SPSS), larger diameter seekers (nominally seven inches) with enhanced terminal homing characteristics and a radio frequency target designation system (RFTDS). The SPSS effort will consist of the development of a form, fit and functional 2.75-inch diameter RF/IR seeker for laboratory and captive flight testing. The SPSS seeker will be integrated with the RFTDS for performance evaluation. The larger diameter dual mode efforts will be directed toward the exploration of advanced terminal homing modes including imaging infrared and millimeter wave sensors. Digital - Begin demonstration of low cost higher order language compiler methodology; continue investigation of compiler for distributed processors; initiate investigation to determine criteria for application of distributed processing to on-board missile system guidance and control; demonstrate distributed microprocessor communication on the standard buss configuration and expand basic missile computer hardware design into a modular, microprocessor-computer family concept. Simulation Research - Complete a full-up distributed radio frequency source generator; develop complex scene generators in infrared/ultraviolet regions; complete development of a data acquisition system and parallel digital processor to enhance simulation operations and data manipulation; conduct design studies for a millimeter simulation system; develop simulation models of air defense suppression missile threats. Experimental Systems - Determine lethality of a high explosive warhead for the rifleman's assault weapon (RAW); complete exploratory development of the special hard target assault weapon LAW (SHAWL); continue development of critical brassboard components for early demonstration of a fire-and-forget antitank system technology (FFAST) concept; continue integration of missile and rocket systems for Army and Navy small water craft; prepare request for proposal for validation phase and initiate evaluation of proposals for field artillery missile system concepts. Aerodynamics - Complete and experimentally verify the Joint Army/Navy/National Aeronautics and Space Administration/Air Force Rocket Plume Analysis Program; conduct final flight tests and assess potential performance of fiber-optics guidance concept; conduct wind tunnel tests to obtain data to upgrade simulation of submissile deployment; conduct wind tunnel tests to support simulation of high performance fire-and-forget missiles; conduct final flight tests and assess potential performance of hypervelocity penetrator antiarmor concept. Propulsion - Initiate quantitative assessment of the flash of minimum smoke propellants; evaluate fluorocarbon binders as a way to achieve high performance low burning rate propellants; demonstrate reduced noise propulsion for application to military operations in built up areas. Ground Support Equipment - Continue development of low signature launching techniques for applications to military operations in urban terrain; perform empirical verification of analytical launcher model; procure hardware for checkout of effects of rocket motor flexibility on launcher accuracy; continue investigation of design techniques for protecting aircraft stores from icing; evaluate results of low cost container/launcher testing and incorporate the optimum materials and techniques into an advanced design; design modifications for existing track mount for improved accuracy at extended ranges; select automatic test equipment concepts for development and begin testing; complete technology for multiple launcher which re-aims between rounds in a ripple.

Program Element: #6.23.03.A

DoD Mission Area: #144 - Guided Missile and Rockets

Title: Missile Technology

Budget Activity: #1 - Technology Base

Structures - Continue tests of commercially available composite structural shapes; demonstrate resolution of acoustical holograms taken in air; develop failure criteria for composite bodies with known flaws; define impact of high energy laser environment on missile radome design; complete development of self-forging fragment warhead structures for application with over-armor guidance techniques; develop missile dynamics sub-scale modeling techniques. Technology Integration - Develop FY 1981 Army missile technology base plan; evaluate foreign technology programs; conduct technology assessment on missile modularity; provide technology planning for evolutionary/modular improvements and developments; conduct independent research and develop (IR&D) on-site reviews and analyze IR&D programs for potential solutions to critical Army needs. Systems Concepts and Analysis - Perform user requirements analysis required for advanced missile system planning; provide in-house analysis and definition of optional system approaches to documented weapon requirements. Sensors and Control for Guided Projectiles - Initiate integration and testing of g-hardened sensor components and systems for indirect fire application; develop and test hardened sensor components and systems for direct fire application. Hybrid Microelectronics - Develop plasma spray for 2 mil lines with 4 mil centers; develop thermal analysis software package for interactive design system; complete flexible active device program; develop a large scale hybrid design for a digital autopilot. This program supports 183 professional and 217 support personnel.

4. FY 1981 Planned Program: Anticipated accomplishments by technology are as follows: Sensors - Continue development of track-while-scan radar, acoustic seekers, carbon dioxide beamrider guidance, millimeter wave guidance, and sensor design and signal processing techniques. Guidance and Control - Develop a laser inertial measuring unit oriented toward air defense application; continue development of digital autopilots; continue development of correlation techniques for improved fire control; develop an all-digital strapdown inertial measuring unit; develop inertial technology for a low cost gyrocompass, low cost gyros, compliant bearings, and multisensors; continue to extend the laser designator/weapon system simulation (LDWSS) to infrared and millimeter applications. Terminal Guidance - Update and validate infrared weapon system simulation (IRWSS) for support of such weapon systems as HELLFIRE and COPPERHEAD, and the Assault Breaker concept; continue to develop and evaluate the dual mode laser/infrared (IR) seeker; perform design studies and/or experimentation on antiradiation seeker and guidance concepts; complete exploratory development of a tactical configuration long wavelength active laser seeker; continue terminal homing measurements program. Digital - Continue compiler and distributed processing technology; begin demonstration of the missile microprocessor computer family using the low cost standard buss structure; develop and test hardware and software to optimally demonstrate the effectiveness of distributed microprocessors in a missile system. Simulation Research - Evaluate analytic radio frequency target and clutter models; complete development of complex scene generators in infrared/ultraviolet regions; procure an enlarged visible terrain model; continue development of a high speed parallel digital processor; continue design studies for a millimeter simulation. Experimental System - Begin development of flight demonstration hardware for fire-and-forget antitank system technology (FFAST) concept; begin concept definition of a weapon system for application to military operations in urban terrain; initiate concept definition of an all-weather, airborne antitank concept; complete evaluation of validation phase proposals for field artillery missile system concept. Aerodynamics - Expand technology base associated with flow interference phenomena affecting direct fire missiles; transition fiber-optics guidance concept to advance development; expand submissile aeroballistics technology; expand aerodynamic technology associated with air defense missiles of advanced configuration design; transition hypervelocity

Program Element: #6.23.03.A

DoD Mission Area: #144 - Guided Missile and Rockets

Title: Missile Technology

Budget Activity: #1 - Technology Base

antiarmor concept to advanced development; initiate new work areas in advanced aerodynamic control technology and elastic airframe effects on missile performance. Propulsion - Characterize bonding agents, improved polymers, oxidizers, and plasticizers for the next generation of improved propellants; demonstrate improved performance/lower cost propulsion system for possible evolutionary improvement to the US ROLAND air defense system. Ground Support Equipment - Complete system type tests and evaluate data for low signature launching technique; conduct tests and gather data on effects of rocket flexibility on launching accuracy; continue investigation of design techniques for protecting aircraft from icing; prove functional capability of low cost container/launcher; continue improvements to under-armor tracking mounts; design and fabricate automatic test equipment. Structures - Characterize flaws and fractures for composites and new metal alloys associated with missile system structures; continue development of analytical methods and models associated with structure analysis; initiate development of a mathematical model of a sealed missile system for various transpiration and leakage conditions for application to the design of seals and materials. Technology Integration - Continue to evaluate foreign technology programs as required; conduct independent research and development (IR&D) on-site reviews and analyze IR&D programs for potential solutions to critical Army needs. Systems Concepts and Analysis - Continue to perform user requirements and provide in-house analysis and definition of optional system approaches to documented weapon requirements. Sensors and Controls for Guided Projectiles - Initiate efforts to defeat countermeasures directed against indirect and direct fire systems. Hybrid Microelectronics - Continue with fabrication and testing of plasma spray; complete design, fabrication and flight qualification of large scale hybrid digital autopilots; continue development of an interactive design system.

5. Program to Completion. This is a continuing program. Following areas will be emphasized: (a) reduction of air defense vulnerability to antiradiation missiles; (b) all-weather, countermeasure hardened, fire-and-forget seekers with multimode capability; (c) millimeter wave seekers and beamrider guidance concepts; (d) low cost inertial guidance; (e) minimum signature propulsion; (f) simulation; (g) digital technology for tactical missiles; (h) low signature launching techniques; (i) more accurate under-armor tracking systems; (j) application of composite structures for reduced weight, higher performance and reduced cost in missile/rocket systems; (k) improved efficiency in structure analysis; and (l) automatic tracking algorithms.



# FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.23.07.A

DoD Mission Area: #152 - Ordnance Technology

Title: High Energy Laser (HEL) Technology  
Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	<u>TOTAL FOR PROGRAM ELEMENT</u>	<u>0</u>	<u>0</u>	<u>1500</u>	<u>2000</u>		<u>Not Applicable</u>
A139	High Energy Laser Technology	0	0	1500	2000	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army High Energy Laser (HEL) program seeks expansion of the HEL technology base and exploration of potential use of the HEL in weapon systems for a variety of Army mission applications. This program element funds the exploratory development portion of that effort, emphasizing improvements in laser components and subsystems, and systematic pursuit of new endeavors in laser science and quantum physics to provide new insights and conceptually innovative laser principles for use in Army mission applications.

C. BASIS FOR FY 1980 RDTE REQUEST: Continued development of closed cycle circulator technology for electric discharge lasers; development of an experimental propagation and effects data base for pulsed chemical lasers; continued development of swept-gain superradiance devices; development of condensed computer codes for use in total system modeling programs; and continued mentorship of particle beam technology for comparison with high energy laser technology for mission applications.

## D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
RDTE					
Funds (as shown in FY 1979 submission)		Not Shown			

Program Element: #6.23.07.A  
DoD Mission Area: #152 - Ordnance Technology

Title: High Energy Laser (HEL) Technology  
Budget Activity: #1 - Technology Base

This effort is being broken out into its own separate program element in FY 1980. In FY78 and 79, exploratory development of high energy laser concepts was accomplished as a task in PE 6.23.03.A, Missile Technology.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.23.07.A

DoD Mission Area: #152 - Ordnance Technology

Title: High Energy Laser (HEL) Technology

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: A High Energy Laser (HEL) has several unique generic properties: small beam divergence - a small spot of intense radiation can be precisely placed on small targets, or on a small vulnerable area of a large target; speed of light delivery - aiming error can be sensed immediately and corrected, and the target cannot evade the laser beam; short dwell time required to accumulate lethal damage - short engagement time; low fuel ("ammunition") consumption per shot - permits many shots to be stored on board. These properties give a weapon system a high potential in a high target density environment. HEL weapon development includes the following areas: (1) the laser device - the beam generator; (2) beam control devices - the pointer/tracker which directs the beam precisely to the aimpoint; (3) propagation - study of the attenuation and distortion of the laser beam as it travels through the atmosphere, and compensation techniques to maximize energy delivery on target; and (4) damage effects and vulnerability. The Army's exploratory development portion of the High Energy Laser program concentrates upon three broad areas: (1) understanding the basics of laser physics and the investigation and characterization of certain types of lasers, (2) establishing the modes which reduce internal laser energy losses and propagation losses, and (3) delineation of regimes of laser energy interaction with targets as a function of energy, waveform, and target material to optimize means for creating target damage.

G. RELATED ACTIVITIES: In FY 1978 and FY 1979, exploratory development of high energy laser concepts was conducted as a task in Program Element (PE) 6.23.03.A, Missile Technology. Army advanced development of the high energy laser is accomplished in PE 6.33.16.A, High Energy Laser Components. Army research in high energy lasers is accomplished in PE 6.11.02.A, Defense Research Sciences. Other high energy laser development is being accomplished by the Navy (PE 6.37.54.N, High Energy Laser), Air Force (PE 6.36.05.F, Advanced Radiation Technology and PE 6.26.01.F, Advanced Weapons), and the Defense Advanced Research Projects Agency (DARPA) (PE 6.23.01.E, Strategic Technology). The different battle environments and system platforms for each Service require a significantly different HEL technology. The Service programs are closely coordinated by the Office of the Under Secretary of Defense (Research and Engineering). A number of the work efforts in the Department of Defense HEL program are jointly funded and performed. In prior years, Army HEL development has been funded under PE 6.21.39.01.A (High Energy Laser Research), 6.23.03.A (High Energy Laser Research), 6.26.03.A (High Energy Laser Research), 6.26.09.A (Project EIGHTH CARD), 6.26.12.A (Project EIGHTH CARD), 6.27.03.A (High Energy Laser Research), 6.27.05.A (High Energy Laser Research), 6.26.21.A (Laser Technology and Applications), and 6.36.11.A (High Energy Laser Development, Advanced Laser Development, and Project EIGHTH CARD).

H. WORK PERFORMED BY: The principal performing organization will be the in-house laboratory of the High Energy Laser Center (Provisional), of the US Army Missile Research and Development Command, Redstone Arsenal, AL; assisted by other Army laboratories, and the national laboratories at Los Alamos, NM; and Livermore, CA. Universities and non-profit organizations will be utilized in portions of the program where specialized knowledge and peculiar facilities are required.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:



Program Element: #6.23.07.A  
DoD Mission Area: #152 - Ordnance Technology

Title: High Energy Laser (HEL) Technology  
Budget Activity: #1 - Technology Base

1. FY 1978 and Prior Accomplishments:

- a. Closed Cycle Circulator. Closed cycle circulators are desired in electrical discharge lasers to reduce the amount of laser gas needed. A closed cycle circulator test bed was fabricated to study the application of platinum catalyst in the gas loop to remove species responsible for poisoning the medium and to investigate pressure pulse attenuation by insertion of an acoustic filter in the loop.
- b. Nuclear Pumped Laser. Experiments were performed to study the laser energy produced by pumping KrF and N<sub>2</sub> gases by proton beams which simulated the excitation produced by alpha particles produced in the collision with a neutron flux from a nuclear reactor.
- c. Laser Induced Effects.

2. FY 1979 Program:

- a. Closed Cycle Circulator. Data will be gathered on the efficiency of the platinum catalyst unit to reduce poisoning of the laser gas medium. An RF quadrupole spectrometer will be used to identify the species formed and the level of these contaminants as a function of system parameters and cycling time. The pressure variations in the laser medium will be measured by optical interferometric techniques and by pressure gauges, to determine the attenuation of pressure pulses by the acoustic filter.
- b. Laser Induced Effects. Susceptibility of energy will be determined as a function of solid angle subtended, at various laser wavelengths and with various types of waveforms, including single and repetitive pulses  
As a  
will be  
measured. This is a continuation of measurement program begun in FY 1978.

3. FY 1980 Planned Program:

- a. Closed Cycle Circulator (CCC). Electric discharge laser system efficiency can be improved by a CCC to process and return used gas to the laser. Problems in acoustics and contamination of gas due to plasma chemistry residues (e.g. HNO<sub>2</sub>) must be solved. Loading to 700 joules/liter (pulsed) is possible for clean gas but loading drops significantly after only one pass through the laser. Additionally, acoustic energy associated with the shock waves generated in a pulsed EDL and in the CCC com-

Program Element: #6.23.07.A  
DoD Mission Area: #152 - Ordnance Technology

Title: High Energy Laser (HEL) Technology  
Budget Activity: #1 - Technology Base

pressor must be properly dissipated to provide a smooth flow of gas. The FY80 program will demonstrate cavity loading for repetitive pulses and provide a data base for repetitively pulsed electrical discharge laser - CCC laser system design. The facility will concurrently be used as a proof test system for new designs for electron beam generators. The Army's Closed Cycle Circulator (CCC) is intended to provide essential design and engineering data for fieldable closed cycle repetitively pulsed electric discharge lasers. Examples of specific issues to be addressed are: plasma chemistry, acoustics, electron beam optimizations, system transients characterization, gas recycle properties, component function and reliability.

b. Pulsed Chemical Lasers. Pulsed chemical lasers are currently being developed under Defense Advanced Research Projects Agency funding to exploit the operational characteristics which are significantly different from continuous wave chemical lasers. The pulsed chemical laser can be operated at close to one atmosphere cavity pressure, and thus potentially can eliminate the need for an exhaust gas pumping system. The pulsed energy has the potential for improved atmospheric propagation and enhanced target damage effects when compared to continuous wave energy applied at the same average power level. The pulsed chemical laser concepts currently under development are for open cycle devices with the reaction products discharged to the atmosphere. The pulsed chemical laser devices, which are presently being developed and demonstrated at AVCO Everett Research Laboratory and TRW Systems, Inc., will be utilized under contract to develop propagation and effects data specifically for Army interests. In-house analysis and experiments will investigate concepts needed to implement closed cycle, pulsed chemical laser operation. Two concepts will be evaluated. The first concept will utilize a solid bed chemical reactor, suitably designed to provide acoustic suppression and toxic gas removal by chemical reaction. Recycling of inert gas can then be done. The second concept will investigate the feasibility of aerosol injection to achieve acoustic damping and reaction of toxic gas. The pulsed chemical laser can potentially be applied to Army missions which may require either a fixed site or a mobile laser device. Evaluation of the concept for Army applications will require (1) definition of the propagation properties of pulsed laser energy and (2) definition of repetitive pulsed energy effects against Army targets. Eventual utilization of the pulsed chemical laser will require the development of a closed cycle device or a very efficient, compact scrubber to remove toxic compounds from the laser effluent.

c. Swept Gain Superradiance (SGSR). Swept-gain superradiance is the nonlinear asymptotic response of a high gain, low loss medium to swept excitation at the speed of light in the medium. Coherent unidirectional pulses are generated. Methyl fluoride SGSR was proven in the 6.1 basic research program. Theory also predicts that other short wavelength SGSR media should exist, e.g., metal vapors should produce the same effect at shorter wavelengths. Suitable pump energy and wavelength must be used. Completion of proof-of-concept, development of scaling laws, discovery of new SGSR wavelengths, and completion of data base will be pursued under the SGSR 6.2 program. SGSR provides a new concept in radiation sources for infrared (or possibly visible) radiation sources. Application in the area of coherent imaging appears to be possible. If so, SGSR will provide extremely short intense pulses/pulse trains at a variety of wavelengths for a wide spectrum of laser imaging systems. High Energy Laser (HEL) systems applications call for spotting of the HEL beam on a specific location on the target. SGSR is capable of providing the detailed image (due to its short intense pulse) required for HEL fire control.

Program Element: #6.23.07.A

DoD Mission Area: #152 - Ordnance Technology

Title: High Energy Laser (HEL) Technology

Budget Activity: #1 - Technology Base

d. Laser and System Modeling. A number of computer codes are presently available to describe all aspects of laser performance. Current activities are centered around better modeling of cavity codes and include refinements such as rotational non-equilibrium and distributed gain. Progress is being made in prediction of laser spectral distribution and power extraction. The FY80 effort will integrate these codes into a new system analysis program. The most accurate codes are extremely long. For systems analyses, shorter "algorithms" are needed, but must be checked for accuracy. Laser and system modeling codes will be collected, selected and integrated to provide a comprehensive computation base for Army High Energy Laser (HEL) R&D. Specifically, new codes, code overlays, etc., will be developed to fill computation capability "gaps" identified earlier. New ideas and methods will be sought to more effectively model HEL's and HEL systems.

f. Particle Beam. Research on the use of electron, ion, and neutral particle beams as potential kill mechanisms has been underway for at least a decade by various elements of DoD. This task consists of monitoring current DoD efforts in this area, performing studies of promising concepts and reporting on status and possible applications. Comparisons of potential performance between particle beams and laser beams will be made.

g. There are 11 professional and 2 support personnel involved in the above efforts for FY80.

4. FY 1981 Planned Program:



Program Element: #6.23.07.A  
DoD Mission Area: #152 - Ordnance Technology

Title: High Energy Laser (HEL) Technology  
Budget Activity: #1 - Technology Base

- a. The Closed Cycle Circulator experimental assembly will be operated as a functioning laser in pulsed and CW modes to gather laser energy - material interaction data with targets of Army interest. It is anticipated that pulsed chemical lasers will have reached the decision point for a judgement to be made as to whether an experimental pulsed chemical laser should be built for extensive study. The swept-gain superradiance phenomenology will continue to be investigated to compare power, pulse width, etc., with theory.
- b. Laser Energy Interaction. Experiments will be continued to measure degradation of  
Characterization of the power required.  
of solid angle subtended, will be continued. The physics of intense charged and neutral particle beams incident on targets will continue to be studied, as will technologies for generating beams with the required energy.

5. Program to Completion: This is a continuing program.

FY 1980 RDTF CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.26.01.A  
DoD Mission Area: #149 - Land Mobility Technology  
Title: Tank and Automotive Technology  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
AI91-01	Mobility		1948	5265	6830	8445	Continuing	Not Applicable
AI91-02	Systems Integration		1614	1937	2659	3239	Continuing	Not Applicable
AI91-03	Survivability		2200	2220	2120	2705	Continuing	Not Applicable
AI91-04	Support		608	840	290	425	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army must have ground combat vehicles equal to or superior to those of potential adversaries. These combat vehicles must be supported by tactical vehicles capable of providing logistical support under all battlefield conditions. This program provides the technology base for the development of these militarily unique vehicles and their components.

C. BASIS FOR FY 1980 RDTF REQUEST: To provide the technological advances necessary to enable propulsion systems used in military ground vehicles to achieve reductions in fuel consumption and wider multifuel capability. To achieve new technology in reducing engine cooling requirements and decreasing weight and volume for equal power levels. To develop innovative track and suspension components that will improve cross-country performance; reduce cost, weight, and maintenance burden; provide more stable platform for gun stabilization; and increase survivability. To examine new concepts in armor materials and armor configurations to improve survivability of combat vehicles. To employ new technology in computerized techniques and microprocessors to improve vehicle design and simplify crew functions in responding to high threat targets.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Costs
RDTF Funds (as shown in FY 1979 submission)	6370	10262	10770	Continuing	Not Applicable

The increased funding in this program reflects increased Army interest in Air Filtration Technology and Nuclear Bacteriological Radiological technology.

Program Element: #6.26.01.A

DOD Mission Area: #149 - Land Mobility Technology

E. OTHER APPROPRIATION FUNDS: Not applicable.

Title: Tank and Automotive Technology  
Budget Activity: #1 - Technology Base



Program Element: #6.26.01.A

DoD Mission Area: #149 - Land Mobility Technology

Title: Tank and Automotive Technology

Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** The fielding of qualitatively superior military vehicles requires that technology be developed well in advance of expected operational requirements. The objective of this program element is to develop that technology required in ground vehicles which will: (1) produce combat and other ground vehicles that have the capability to defeat prospective threats in any operational environment; (2) minimize the total costs of these systems; (3) reduce time and risks of new development; and (4) increase survivability and efficiency.

**G. RELATED ACTIVITIES:** Specific programs related to the technical areas of this program element (PE) are: PE 6.11.02.A, Project F72, Research in Vehicle Mobility; PE 6.21.05.A, Materials; PE 6.26.03.A, Large Calibre and Nuclear Technology; PE 6.27.33.A, Mobility Equipment Technology; PE 6.26.18.A, Ballistics Technology; PE 6.31.02.A, Materials Scale-up; PE 6.32.01.A, Aircraft Power Plans and Propulsion; PE 6.36.08.A, Tank Gun Development and Tank Ammunition; PE 6.36.21.A, Combat Vehicle Power Trains; PE 6.36.31.A, Combat Vehicle Turret and Chassis; PE 6.36.24.A, Mobility; PE 6.23.79.A, Test Measurement and Diagnostic Equipment; and PE 6.36.02.A, Advanced Land Mobility Systems Concepts. Close relationship is maintained with other Services and Governmental agencies. Research and development information concerning Combat, Tactical, and Special Purpose Vehicles is also being exchanged via data exchange agreements with allied countries. Exchange of technical reports and frequent liaison by all agencies concerned occurs to ensure coordination and avoids duplication of effort.

**H. WORK PERFORMED BY:** US Army Tank-Automotive Research and Development Command, Warren, MI, has the responsibility for the implementation of this program. Other Army in-house developing organizations that support this program are: US Army Armament Research and Development Command, Dover, NJ; US Army Missile Research and Development Command, Huntsville, AL; US Army Test and Evaluation Command, Aberdeen, MD; Waterways Experimental Station, Vicksburg, MS; and Cold Region Research and Engineering Laboratory, Hanover, NH. Major contractors participating in the program are: Stevens Institute of Technology, Hoboken, NJ; Purdue University, Lafayette, IN; General Motors, Detroit, MI; Wayne State University, Detroit, MI; National Waterlift Company, Kalamazoo, MI; Lockheed Corporation, Huntsville, AL; Williams Research Laboratory, Walled Lake, MI; Chrysler Corporation, Detroit, MI; and Systems Consultants, Inc., Washington, DC.

#### **I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

1. FY 1978 and Prior Accomplishments: The detailed design analysis of combustion chamber components for the adiabatic engine, a high temperature, minimum cooling engine, was completed. Tests were conducted on hardening vehicle suspension components to withstand mine blasts. An independent external suspension design was finalized and component parts were fabricated. A plan was generated to increase the fire survivability of ground combat vehicles, including the retrofit of US vehicles in Europe, with near and mid-term improvements in FY 1982. Advanced Techniques for Electrical Power Systems (ATEPS) brassboard hardware successfully demonstrated the feasibility of providing crew members with information on vehicle operational status

Program Element: #6.26.01.A  
DoD Mission Area: #149 - Land Mobility Technology

Title: Tank and Automotive Technology  
Budget Activity: #1 - Technology Base

and faults, and the potential for greatly reducing maintenance time through simplified wiring harnesses and automatic fault isolation. A computerized procedure for armored vehicle design and evaluation against high explosive (HE) fragments was completed which provides a significant improvement in the ability to design and evaluate combat vehicles. The microprocessor logic for the acoustic detection of an attack helicopter in a buttoned-up combat vehicle was completed. A Survivability Optimization Model which evaluates the survivability of combat vehicles under attack by a variety of weapons to include antitank guided missiles was improved.

2. FY 1979 Program: Preliminary testing will be performed on a full adiabatic multicylinder engine. This engine will dramatically improve fuel economy and increase power for the same fuel input by 30% over current diesel engines and will result in approximately a 40% reduction in both weight and volume for the same horsepower level. Ceramic coatings for turbine engines will be investigated which will permit higher operating temperatures with accompanying increased performance. Independent External Suspension units will be tested. These units greatly simplify combat vehicle suspensions while reducing vehicle weight and silhouette. Loopwheel component fabrication will be completed and tested on a 3000 pound demonstration vehicle. This suspension system, an innovative approach which eliminates wheels and springs, significantly reduces suspension parts and weight, and improves reliability, availability, and maintainability. To significantly reduce the time and cost involved in conducting a test until an item fails, a methodology for failure prediction techniques will be developed. Laboratory evaluation of sensor false alarm tests, response times, and discharge valve release times will be conducted. This effort will contribute, ultimately, to the qualification and standardization of fire detection and suppression systems. Laboratory tests will measure vehicle leakage, overpressure requirements, and cooling to alleviate heat stress on crew personnel wearing Nuclear Biological Chemical protective equipment. The Advanced Techniques for Electrical Power Systems (ATEPS) feasibility demonstration will be completed this year. Kevlar and glass reinforced plastics, as well as the other lightweight materials, will be evaluated for ballistic protection. Laboratory dynamic analysis of high strength metallic materials will be conducted to determine the optimum characteristics for application to critical vehicle components. A stabilization and heading reference unit will be developed employing gyroscopes, already available within the existing stabilization systems, to provide inertial measurements necessary to navigate combat vehicles under conditions of darkness and battlefield obscuration. Breadboard versions of vehicle integrated defense concepts for the detection, discrimination, and reactions to threat systems will be fabricated. Photometric advanced countermeasures will be developed using pattern recognition methodology to guide reaction efforts concerned with surface reflection, visual cues, and lighting system configurations. The development of vented ammunition storage compartmenting will be initiated to minimize catastrophic damage to combat vehicles suffering penetration and secondary detonations. Prototype compartments will be designed with the aid of improved computer models.

Program Element: #6.26.01.A  
DoD Mission Area: #149 - Land Mobility Technology

Title: Tank and Automotive Technology  
Budget Activity: #1 - Technology Base

3. FY 1980 Planned Program: Technology efforts in the area of advanced high temperature diesel engine components will begin. Ceramic coatings for turbine engines components will continue to be investigated. Efforts will be initiated on a new-stationary high temperature advanced recuperator to achieve compatibility with the 2500 degree Fahrenheit gas temperature specified for an advanced turbine engine. Engine concepts for non-petroleum fuels will be investigated. Field testing of the Independent External Suspension will be completed. The initial loopwheel suspension test will be finished. The design of the Bi-Directional Suspension (movement in both horizontal and vertical planes) will be completed and tested. Software will be developed for automatic generation of vehicle simulations which will reduce the time required for a vehicle simulation from eight weeks to four days. Research in advanced diagnostic techniques will be expanded to such applications as the Improved TOM Vehicle and Fighting Vehicle Systems. The fabrication of advanced composite materials and structures such as springs, frame rails, and drive shafts of graphite/epoxy will be completed and fatigue tested in the laboratory. High strength materials components will be fabricated and tested. Vehicle countermeasures concepts will be developed and evaluated emphasizing the reduction of overhead susceptibility to laser guided weapons and threats employing terminal homing. Compartmented ammunition concepts will be fabricated and validated through live firings. Integrated passive countermeasure systems will be investigated which combine radar, seismic, magnetic, photometric, infrared, laser, and acoustic susceptibility reduction techniques. There are 90 personnel and 24 support personnel involved in these efforts.

4. FY 1981 Planned Program: Advanced adiabatic components exploratory investigations of various friction reduction techniques will continue to be explored using gas bearings and advanced ceramic materials and unique designs. An advanced radial inflow turbine rotor vane and combustor will be ceramically coated and tested. Non-petroleum fuels will be evaluated using different fuel injection techniques. The bi-directional suspension system will be tested. Fabrication of a low friction combat vehicle drive spocket and front idler system that will reduce the energy consumed by combat vehicle tracks will be completed. A new system of using lubricated pins in combat vehicles tracks, as opposed to the current system of rubber bushings, will be evaluated. Compartmented hydraulic and fuel prototype hardware will be tested, evaluate fire vulnerability improvements. Ballistic proof tests will be performed for methods for reducing shock damage to critical components. Tests on advanced composite materials and will be completed. Vehicle modifications to examine new countermeasures will be and evaluated against advanced weapon systems. Ammunition compartmenting designs will be adapted to various vehicle concepts based upon the evaluation of mock-up configuration data. Work will be initiated to control emitted/reflected optical images of combat vehicle systems through the elimination of those characteristics which serve as target identification sources. Using image analysis techniques, detection cues will be established, quantified, and altered as required to minimize surveillance vulnerability.

5. Program to Completion: This is a continuing program.



FY 1980 RITE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.26.03.A

Title: Large Caliber and Nuclear Technology

DoD Mission Area: #145 - Guns and Related Technology

Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	21435	25369	24772	24743	Continuing	Not Applicable
AH18-01	Armored Fighting Vehicles (Large Caliber Systems)	1763	4921	1180	1520	Continuing	Not Applicable
AH18-02	Armored Fighting Vehicles (Medium Caliber Vehicles)	4680	2500	2500	0	Continuing	Not Applicable
AH18-03	Armored Fighting Vehicles (Precision Armaments)	1500	1210	1200	1700	Continuing	Not Applicable
AH18-04	Infantry Armament Systems	1950	853	750	1600	Continuing	Not Applicable
AH18-05	Artillery Armament Systems	2000	1685	1580	2100	Continuing	Not Applicable
AH18-06	Advanced Artillery Systems						
	Test Beds	1576	2400	5795	2340	Continuing	Not Applicable
AH18-07	Combat Aviation/Air Defense	0	0	0	0	Continuing	Not Applicable
AH18-08	Combat Engineer Armament						
	Support	700	600	600	930	Continuing	Not Applicable
AH18-09	Energetic Materials						
	Technology	1400	1640	1350	2200	Continuing	Not Applicable
AH18-10	Weapons Technology	1200	1000	920	1726	Continuing	Not Applicable
AH18-11	Munitions Technology	1500	1700	2370	2020	Continuing	Not Applicable
AH18-12	Weapons Munitions Interface	1816	1760	1250	1807	Continuing	Not Applicable
AH18-13	Nuclear Munitions						
	Technology	1300	1300	1360	1950	Continuing	Not Applicable
AH18-14	Fuze Technology	50	3800	3917	4300	Not Applicable	Not Applicable
AH18-15	Training Munitions	0	0	0	550	Not Applicable	Not Applicable

Program Element: #6.26.03.A  
 DoD Mission Area: #145 - Guns and Related Technology  
 Title: Large Caliber and Nuclear Technology  
 Budget Activity: #1 - Technology Base

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** The Large Caliber and Nuclear Armaments Technology program performs exploratory systems development and necessary supporting research to further the state-of-the-art in weapons, munitions and their interfaces. The output of this program is used in defining promising revolutionary systems as well as product improvements associated with evolutionary development. The program scope covers the system oriented technical areas of armored fighting vehicle armament (75mm, 105mm and 120mm), infantry armament systems (indirect and remote fire systems and 81mm Recoilless Gun for MOUT), artillery armament systems (Target seeking munitions, Howitzer Test Beds and light artillery Division System), combat aviation/air defense systems (unfunded in FY80), and combat engineer support (mines and demolition systems). The scope further embraces support technologies in the areas of energetic materials (explosives, propellants and pyrotechnics), weapons, munitions, weapon/munition interface, nuclear technology, fuze technology and training munition technology. These efforts form the foundation for all subsequent weapon and munition advanced developments, engineering developments as well as many product improvement programs. A fundamental commitment has been made to address the User requirements and priorities as defined in Science and Technology Objectives Guide, FY 1979 (STOG-79).

**C. BASIS FOR FY 1980 ROTE REQUEST:** Exploratory development of the 75mm automatic cannon/ammunition system will be completed, the guidance link for Cannon-Launcher Beam Rider Projectile (CLBRP) and Tube-Launched Guided Projectile components (TLGP) will be tested and the two concepts will be evaluated. Performance of target-seeking munitions, sub-systems controlling flight stability and maneuverability, will be tested. Transponder systems for Artillery Registration and Adjustment System (ARADS) will be tested. System performance model for Howitzer Test Bed III, including fire control, autoloader and recoil system models, will be completed. Comparison with M109A1 and foreign S.P.H. systems initiated and effort in Improved Sensing Munitions (ISM) for direct and indirect fire roles for recoilless, mortar and artillery systems, including development of Self-Forging Fragment (SFF) kill mechanisms and associated sensors will begin. Technology base effort in energetic materials, insensitive high explosives and propellants, wear and erosion reduction by means of coatings, liners and additives, nuclear munitions, safety and arming components and air defense proximity fuzing, pulse power sources and transparent impact sensing ogives for precision-guided munitions will continue.

**D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)**

ROTE Funds (as shown in FY 1979 submissions)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Costs	Not Applicable
	22665	21128	26641	Continuing		

Program Element: #6.26.03.A  
DoD Mission Area: #145 - Guns and Related Technology

Title: Large Caliber and Nuclear Technology  
Budget Activity: #1 - Technology Base

Additional funding has been added by Congress to this program element for FY 1979. The funding will be applied to technical area 01 to support the development of the 105mm Armor Piercing Fin Stabilized Discarding Sabot (APFSDS-T) XM813 cartridge to combat the more advanced enemy threats projected beyond the 1982 time frame; and the 105mm High Explosive Antitank Multipurpose Tracer (HEAT-MP-T) XM815 cartridge. This round will provide a significant increase in capability against armor, personnel, materiel, and helicopter targets for the current and future main battle tank force. The reduction in the current FY 1980 request compared to the estimate in FY 1979 is attributable to the XM833 and XM815 cartridges being transitioned into Advanced Engineering phase, and movement of funding to higher priority Army systems. The reduction of \$1,230(M) in FY 1978 funding compared to the estimate as shown in FY 1979 RDT&E Congressional Descriptive Summary is attributable to the deletion of all funding for large caliber combat aviation and air defense weapon gun systems technology studies and reduced funding for munitions technology, ancillary rounds of large armored fighting vehicles, and precision munitions.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.26.03.A  
DoD Mission Area: #145 - Guns and Related Technology

Title: Large Caliber and Nuclear Technology  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The Large Caliber and Nuclear Technology project performs exploratory development and necessary supporting research in weapons and munitions technology. The product of this effort is used to conceptualize revolutionary weapon and munitions systems, as well as define ways of product improving the current systems to extend their useful life. The program scope covers the system oriented technical areas embracing armor, infantry, field artillery, air defense artillery, aviation, and combat engineering. The program also supports the included technologies of energetic materials (explosives, propellants, and pyrotechnics), weapons, conventional munitions, nuclear munitions and weapon/munition interface, fuzing, and training munitions. The investigations develop both hardware and analytic tools to assess system performance and identify problem areas. The resulting data base forms the foundation for all subsequent large caliber weapon and munition advanced and engineering developments.

G. RELATED ACTIVITIES: Prior to FY 1978, the activity in this area was conducted in Program Elements 6.26.03.A/AH78, Armament Technology; 6.26.17.A/AH79, Munitions Technology; 6.26.15.A/AH 74, Nuclear Munitions; and 6.26.17.A/AH 77, Fuze Technology. During FY 1978, fuze technology efforts were conducted in Program Element 6.21.20.A (Fuze, Nuclear Weapon Effects, Fluidics). Technical areas of this program for FY 1979 are related to Program Element 6.26.17.A, Small Caliber and Fire Control Technology, 6.26.18.A, Ballistics Technology, and numerous advanced and engineering development projects. Coordination of similar efforts conducted by the Air Force and Navy is accomplished by visits of technical personnel, interagency meetings, and Tri-Service reviews and workshops to encourage cross-fertilization and preclude duplication.

H. WORK PERFORMED BY: In-house work is conducted at the US Army Armament Research and Development Command facilities located at Dover, NJ, Aberdeen, MD, and Edgewood, MD. Contract support is provided by Aircraft Armaments, Inc., Cockeysville, MD; Aerojet, Azusa, CA; AVCO, Wilmington, MA; Batelle Memorial Institute, Columbus, OH; Calspan, Buffalo, NY; Chamberlain, Waterloo, IA; Firestone, Akron, OH; Ford-Aerospace and Communications, Newport Beach, CA; Honeywell, Hopkins, MN; Northrop, Anaheim, CA; Sanders Associates, Nashua, NH; Space Research Corporation, Troy, VT; Texas Instruments, Dallas, TX; National Lead of Albany, Albany, NY; and numerous other small contractors.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Demonstrated precision of 75mm telescoped cartridge Armor Piercing Fin Stabilized Discarding Sabot (APFSDS) ammunition and the capability of a new 75mm brassboard gun system to fire burst-fire while mounted on a moving vehicle. Firings of the Smart Target Fire and Forget (STAFF) projectile (less sensor) indicated the potential for a successful concept demonstration. Technology for the next generation Self-Propelled Howitzer was advanced through the fabrication and testing of Howitzer Test Beds I and II which permit automatic gun laying and self-contained position location systems. A self-forging fragmentation warhead compatible with STAFF system design constraints was designed and demonstrated. A 35% reduction in gun tube wear at the origin of rifling was demonstrated in the wear and erosion program.

Program Element: #6.26.03.A

DoD Mission Area: #145 - Guns and Related Technology

Title: Large Caliber and Nuclear Technology

Budget Activity: #1 - Technology Base

2. FY 1979 Program: Conduct a demonstration test firing of Cannon Launched Beam Rider Projectile (CLARP) using a programmable beam projector. Search and Destroy Armor (SADARM) artillery projectile will be submitted to a complete live warhead demonstration. Develop a system performance model for Howitzer Test Bed (HTB) III and a performance rating system to compare HTB's and the M109A1 accuracy and response time. The results will impact HTB III design and future systems. Both types of extended range projectile (Rocket Assist Projectile and sub-caliber) fabricated in FY 1978 will be performance tested in FY 1979. Tests of energetic materials and propellants will continue with the goal of reducing wear and erosion, increasing performance, and reducing vulnerability. A "low-G" sensor will be integrated into a unique signal generating safe and arm device for nuclear munitions. Conduct a study to determine the requirements for the next generation family of artillery fuzes. Initiate development of cartridges 105mm XM815 and XM833.
3. FY 1980 Planned Program: Conduct feasibility demonstration of a multi-penetrator kinetic energy tank cartridge. Field tests of guidance links for CLARP will be conducted. Continue development of the XM815 and XM833 rounds. Conduct ballistic test and verify aerodynamic design, roll and deflection servo design, rate sensor design and maneuverability of a target seeking projectile system. Complete system performance model for HTB III and begin comparison with the M109A1 and foreign systems. Begin effort in Improved Sensing Munitions (ISM) which will include development of kill mechanisms (self-forging fragments) and sensors. Continue technology base efforts in energetic materials, tube wear and erosion, nuclear munitions and fuzing for artillery and tank ammunition. Involved in this effort are approximately one hundred professional and forty one support personnel.
4. FY 1981 Planned Program: Evaluate CLARP and Tube Launched Guided Projectile (TLGP) and determine which system will transition to Advanced Development. Conduct concept feasibility evaluation of Artillery Registration and Adjustment System (ARADS). Extend test methodology for evaluating Insensitive High Explosives (IHE). Continue comparison of performance data from HBT III with existing M109A1 and foreign systems. Begin an effort to develop computer codes for analyzing fuze structural response. The design of an air-defense fuze will be initiated.
5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.26.17.A Title: Small Caliber & Fire Control Technology  
DoD Mission Area: #145 - Guns and Related Technology Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>9915</b>	<b>9448</b>	<b>8598</b>	<b>9609</b>		<b>Not Applicable</b>
AH19-01	Combat Vehicle Armament	2375	2090	1710	1800	Continuing	Not Applicable
AH19-02	Aircraft Armament	715	670	600	659	Continuing	Not Applicable
AH19-03	Light Weapons	1760	1767	1768	1700	Continuing	Not Applicable
AH19-04	Short Range Air Defense	1475	1871	1750	1750	Continuing	Not Applicable
AH19-05	Fire Control Technology	1150	948	1420	1500	Continuing	Not Applicable
AH19-06	Armament Technology	2440	2102	1400	1400	Continuing	Not Applicable
AH19-07	Application for Metallic Materials	0	0	750	800	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** The objective of this program is to develop and maintain a technology base upon which advanced and engineering development of fire control and small caliber weapons and munitions can be initiated and sustained. The focus is on exploratory development in fire control technology, munitions, weapons and material applications which is intended to solve critical problems in fire control and small caliber systems design, effectiveness and reliability. The intent is to produce an integrated program of analysis, experimentation, and test demonstration that advances the state-of-the-art and leads to concept validation.

**C. BASIS FOR FY 1980 RDT&E REQUEST:** The funds will support the development and maintenance of a small caliber and fire control technology base encompassing the technical areas related to armament and fire control for combat vehicles, aircraft, light weapons and air defense, and to further generic investigations into the broad areas of fire control and small caliber armaments.



Program Element: #6.26.17.A Title: Small Caliber & Fire Control Technology  
 DoD Mission Area: #145 - Guns and Related Technology Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
Funds (as shown in FY 1979 submission)	10523	9473	6851	Continuing	Not Applicable

The FY78 and FY79 programs were reduced because funds were reprogrammed into higher priority projects. The FY 80 program was increased to support additional efforts in the aircraft armaments, light weapons and short range air defense areas.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.26.17.A  
DoD Mission Area: #145 - Guns and Related Technology  
Title: Small Caliber & Fire Control Technology  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The product of this effort is used to conceptualize revolutionary fire control; weapon and munitions systems as well as to define methods for improving the current systems to extend their useful life. The scope of the program covers the system oriented areas of combat vehicles, aircraft armament, light weapons and short range air defense, and the base technology areas of fire control, armaments and metallic material applications. The investigations develop both the hardware and the analytic tools necessary to assess system performance and to identify problem areas. The resulting data base forms the foundation for all subsequent fire control and small caliber weapon and munition advanced and engineering developments.

G. RELATED ACTIVITIES: Prior to FY78, the activity in this area was conducted in Program Elements (PE's) 6.26.03.A (AH78), Armaments Technology, and 6.26.17.A (AH79), Munitions Technology. The technical areas in this program to FY 1979 are related to PE's 6.26.03 (AH78), Large Caliber and Nuclear Technology; 6.26.18.A (AH80), Ballistics Technology; 6.22.03.A (DH95), Aircraft Weapons Technology; 6.21.05.A (AH84), Materials Technology; and numerous advanced and engineering development projects. The coordination of similar efforts conducted by the Air Force and the Navy is accomplished by visits of technical personnel, interagency meetings, and tri-service reviews and workshops to encourage information exchange and preclude unnecessary duplication.

H. WORK PERFORMED BY: The in-house work is conducted at the US Army Armament Research and Development Command facilities located at Dover, NJ, and Aberdeen and Edgewood, MD. The five largest contractors are Hughes Aircraft Corporation, Culver City, CA; Honeywell Corporation, Minneapolis, MN; AAI Corporation, Cockeysville, MD; Oregon Graduate Center, Eugene, OR; and the Syracuse Research Corporation, Syracuse, NY. In addition, there are contracts with 26 additional vendors with a value of \$1,515,000.

#### 1. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: A prototype heavy general purpose machine gun was designed and fabricated. Difficulties with the projectile miss distance sensor (MDS) were overcome and preparations for demonstration were completed. Thin-wall steel 30mm cartridge cases were fabricated and initial tests were begun. Hardware for a laser rangefinder for light weapons has been developed. Warheads for the Rifleman's Assault Weapon were fabricated and statically demonstrated. Tests of a first generation design low drag projectile were completed and a design was selected for future demonstration in the 35-40mm DIVAD class caliber. Simulation studies indicate that a gun-based air defense system can engage anti-radiation missiles and antitank guided missiles. Dynamic gun pointing accuracy was improved significantly and a prototype modular controller has been designed which implements improved disturbance control logic for the XM97/XM197 turret/weapon. The implementation of the electro-slag remelted technique for processing steel for high performance cartridge cases has been analyzed.

2. FY 1979 Program: Complete system design for the multi-function fire control test bed. The projectile sensing capability of the miss distance sensor (MDS) has been demonstrated. The design of the heavy general purpose machine gun will be refined and a 20mm design completed. The analysis of ammunition candidates for future automatic cannon systems (FACS) will be completed. Tests

Program Element: #6.26.17.A

Title: Small Caliber & Fire Control Technology

DoD Mission Area: #145 - Guns and Related Technology

Budget Activity: #1 - Technology Base

of thin wall steel cartridges will be completed. User tests of a conceptual multi-shot grenade launcher and laser rangefinder sight will be completed. The design of the Millimeter Wave Air Defense Radar will be completed and fabrication initiated. Development of radar concepts incorporating low probability of intercept techniques will be initiated. Firing and non-firing tests of the analog modular controller will be made. Application for nitramine/nitrocellulose small arms propellants will be analyzed. Design limitations for forming rifling contours by the rotary and button swaging process will be determined.

3. FY 1980 Planned Program: Fabrication of the multifunction fire control test bed will be completed and tests of fire control modules for combat vehicles will be initiated. A trade-off analysis and concept development on a High Impulse Precision Armament System will be initiated. The concept definition of a controlled burst rifle will be continued. The fabrication of the Millimeter Wave Air Defense Radar will be completed and the evaluation of search and track capabilities will be initiated. The evaluation of conventional low drag DIVADs class ammunition will be completed and transitioned to 6.3A. Implementation of a digital version of the modular controller will be initiated using the XM97/Universal Turret System. Investigation of the feasibility of using compacted powder metals for frangible training projectiles will be initiated. Efforts involve 115 personnel - 87 professional and 28 support.

4. FY 1981 Planned Program: Perform trade-off analysis to determine potential of a high impulse heliborne gun system for an advanced technology demonstration. Concept definition and analysis of a controlled burst rifle will be completed. Concept definition of a dual purpose weapon for the Infantry Fighting Vehicle will continue. The field test of the millimeter Wave Air Defense Radar system will be completed. Implementation of the digital disturbance rejection control system will be completed and testing will be initiated. Development of radar concepts incorporating low probability of intercepts will be continued.

5. Program to Completion: This is a continuing program.



FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.26.18.A  
 DoD Mission Area: #145 - Guns and Related Technology  
 Title: Ballistics Technology  
 Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Continuing	Total Estimated Costs
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>17457</b>	<b>18009</b>	<b>16512</b>	<b>20578</b>		<b>Not Applicable</b>
AH80-01	Propulsion Dynamics and Interfacing	2475	3500	2951	3700	Continuing	Not Applicable
AH80-02	Launch and Flight Dynamics	690	896	900	900	Continuing	Not Applicable
AH80-03	Firing Table Techniques and Production	800	898	900	1000	Continuing	Not Applicable
AH80-04	Warhead Mechanics	3715	2830	2200	2812	Continuing	Not Applicable
AH80-05	Terminal Effects and Armor Dynamics	4262	4155	2565	2500	Continuing	Not Applicable
AH80-06	Armor Vulnerability Technology	755	1000	1500	2983	Continuing	Not Applicable
AH80-07	Target Vulnerability and Lethality	1895	1515	1800	2000	Continuing	Not Applicable
AH80-08	Vulnerability Reduction and Survivability	365	515	1000	1300	Continuing	Not Applicable
AH80-09	Weapon Systems Analysis and Modeling	1310	1600	1200	1800	Continuing	Not Applicable
AH80-10	Advanced Technology Concepts Special Projects	570	1100	1496	1583	Continuing	Not Applicable
		620	--	--	--	Continuing	Not Applicable

Program Element: #6.26.18.A

DoD Mission Area: #145 - Guns and Related Technology

Title: Ballistics Technology

Budget Activity: #1 - Technology Base

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** This program encompasses exploratory development efforts in the technical areas shown in above paragraph A. Hardware constructed within this program is limited to proof of concept laboratory prototypes. The program is needed as a source of technology innovation and advancement that can be exploited by system development under advanced development (6.3) and engineering development (6.4) program elements. Primarily, all efforts within this program element support the Army Science and Technology Objectives pertinent to close combat, fire support, other combat support, and air defense systems.

**C. BASIS FOR FY 1980 RDTF REQUEST:** Emphasis will continue on generation and application of advanced ballistic technology to propellants and reduction of tube wear through improved charge design. Ballistic range tests will be conducted to confirm aerodynamic performance of unusual shaped projectiles and special purpose munitions. Techniques will be optimized to improve fragment beam control and to counter the effectiveness of anti-armor warheads. Armor dynamics efforts will emphasize modeling of structural response, hyper-velocity projectile technology, and methodology for blast wave propagations and predictions. Vulnerability data will be developed for a broad spectrum of materiel and equipment. The benefits of various vulnerability reduction techniques will be evaluated. Milestones will be established in development and application of millimeter wave radar to aircraft tracking.

**D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)**

RDTF Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total
					Estimated Cost
	17507	18309	17570	Continuing	Not Applicable

Differences in funding profiles between the FY 1980 and the FY 1979 Congressional Descriptive Summaries for this program element are attributable to budget constraints. Impact of decrease will be to reduce efforts to acquire data and methods for establishing requirements for spare parts needed for Army materiel as a result of combat damage; and reduce efforts in the development of methods and techniques respectively for vulnerability analysis and vulnerability reduction.

**E. OTHER APPROPRIATION FUNDS:** Not applicable.

Program Element: #6.26.18.A

DoD Mission Area: #145 - Guns and Related Technology

Title: Ballistics Technology

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The objective of this program element is to develop and maintain a ballistics technology base which assures a solid foundation upon which advanced and engineering development of weapon systems can be initiated and sustained. The Ballistics Technology Program focuses on describing closed system ignition and combustions processes (propulsion dynamics); interactions between high pressure gases and the projectile in the tube and as it leaves the tube; the physical and chemical reactions of the hot propellant gases with the atmosphere (propulsion dynamics and launch and flight dynamics); dynamics of projectile flight (launch and flight dynamics); and the delivery of projectile energy to a target (warhead mechanics and terminal effects and armor dynamics). The capability to describe ballistic phenomena comprehensively is critically important to the successful prosecution of advanced and engineering development of weapon systems. Through that capability, state-of-the-art concepts can be identified, developed, and evaluated with minimum costly and time-consuming trial-and-error experiments. In addition, the Ballistics Technology Program develops vulnerability assessment techniques which are used Army-wide by development and analysis agencies to identify system weaknesses and appropriate design changes before production. This formalized vulnerability assessment/reduction effort has improved the survivability of recently developed Army materiel. Equally important, the effort pinpoints and quantifies weaknesses in enemy equipment which are exploited by weapons designers and military doctrine analysts.

G. RELATED ACTIVITIES: These Ballistic Technology efforts are related to development activity in Large Caliber and Nuclear Technology, 6.26.03.A; Small Caliber and Fire Control Technology, 6.26.17.A; and Tank and Automotive Technology, 6.26.01.A. Also, Ballistics Technology efforts are related to similar efforts conducted by the Air Force and the Navy. Visits by technical personnel, interagency group meetings, and tri-Service workshops provide coordination of activities, encourage stimulation and cross-fertilization of ideas and knowledge, and preclude unnecessary duplication of efforts.

H. WORK PERFORMED BY: Approximately 75 percent of the work is conducted in-house at the US Army Armament Research and Development Command facilities located at Dover, NJ; and Aberdeen Proving Ground, MD (Ballistic Research Laboratory). Other participating Army facilities are the US Army Missile Research and Development Command, Huntsville, AL; and the US Army Test and Evaluation Command, Aberdeen Proving Ground, MD. Major contract support is provided by New Mexico Institute of Mining and Technology, Socorro, NM; Lawrence Livermore Laboratories, San Francisco, CA; Firestone Tire and Rubber Company, Dayton, OH; Oak Ridge National Laboratory, Oak Ridge, TN; and Falcon Research and Development, Denver, CO. Other support is provided by an additional eleven contractors, some of whom are unknown because bids will be competitive, at a total cost of \$1240 thousand.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments:



Program Element: #6.26.18.A

DoD Mission Area: #145 - Guns and Related Technology

Title: Ballistics Technology

Budget Activity: #1 - Technology Base

Technological advances in terminal ballistics and propulsion dynamics (propellant optimization) applied to the 105mm tank gun program were also extended to 75mm and 120mm guns. First tests of the low vulnerability ammunition (LOVA) concept for tank gun ammunition were completed. In launch and flight dynamics, the efforts were for projectiles experiencing the change from sub-sonic to sonic velocities, the results of computations to predict aerodynamic characteristics not dependent upon air viscosity effects. These extensive computations give valuable insight about the critical aerodynamic behavior of boattailed (truncated cone base) projectiles near MACH One.

2. FY 1979 Program: Investigations will continue on the concept for a hypervelocity gun and ammunition system; primary emphasis will be placed on demonstrating the ballistic efficiency and feasibility of a traveling charge to provide a muzzle velocity of 2-3 km/s. Parallel efforts will attempt to develop propellants that exhibit low barrel wear and erosion characteristics. Screening tests of five LOVA candidates will be completed.

In launch and flight dynamics, the emphasis will be on the development of a model describing the launch impulse on projectiles so that erratic launch can be minimized or controlled, the assessment of launch and flight projectiles of candidate hyper-velocity projectiles, and further development of codes for computing the effects of interactions between aerodynamic flow properties independent of air viscosity and those properties dependent upon air viscosity. Two items slated for completion are the conceptual design for mortar guided projectiles and a computer model which can be used to assess the influence of vehicle maneuvers, fire control systems, and doctrine on armor protection of the survivability of armored and combat vehicles. Work in millimeter wave technology will continue to establish the feasibility of a Beam Rider Air Defense System (BRADS). Ballistics Technology efforts supporting the Department of Defense (DOD/DoD) assessment of the feasibility and effectiveness of Insensitive High Explosives and Propellants (IHEP) for Army weapon systems will be completed.

3. FY 1980 Planned Program: These funds are required to support the continued development of a sound ballistics technology base and to exploit significant technological opportunities in armor design, shaped charge warheads, and gun propellant systems. This year will mark a critical decision point for the traveling charge concept as the principal propulsion candidate for a hyper-velocity gun. Assuming results to this point are encouraging, goals will be to improve the structural integrity of the traveling charge and the charge/projectile interface and to tailor the charge under realistic, dynamic gun conditions. Major 6.2 efforts on advanced antitank warheads will be completed; warhead areas to be explored are the development of selective initiation schemes to produce different shaped-charges from the same round. Armor effort will continue with the thrust to develop lightweight armor to withstand advanced warheads. Efforts will continue within propulsion dynamics to include new insights into

Program Element: #6.26.18.A

DoD Mission Area: #145 - Guns and Related Technology

Title: Ballistics Technology

Budget Activity: #1 - Technology Base

Interior ballistics phenomena through application of two-phase, two-dimensional flow boundary layer codes developed during previous years. There will be a reemphasis on a broad-based program to support future kinetic energy weapons systems development. Results should provide optimization information for kinetic energy penetrators. Efforts supporting obscuration/obscuration mitigation technology will include propagation/attenuation measurements on newly-developed Army-Navy broad-band obscuration; small-scale field evaluations of obscuration mitigation techniques; and analysis of the effects of multispectral screening agents of current and proposed armament systems, with particular emphasis on improving sensing munitions. To conduct these efforts 150 professional and 138 technical support personnel are involved.

4. FY 1981 Planned Program: Accomplishments projected for this fiscal year include the start of a major program to demonstrate an air defense gun system capable of muzzle velocities in the 2-3 km/s range; concepts for multipurpose lethal mechanisms and technology applicable to the top-surface attack of heavily armored vehicles; vulnerability analysis of hazards in current shipment methods and storage configurations (both long term reserve and under combat conditions), and vulnerability techniques following from improved knowledge of explosive and propellant sensitivity; structural response codes for the assessment of vulnerability of military targets to nuclear attack; establishment of vulnerability/lethality detachments at various commands; breadboard demonstration of feasibility of 140 gigahertz millimeter wave application to Beam Rider Air Defense System (BRADS).

5. Program to Completion: This is a continuing effort.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.26.22.A

Title: Chemical Munitions and Chemical Combat Support

DoD Mission Area: #135 - Chemical-Biological Warfare Technology Base

Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total	
								Estimated Costs	Not Applicable
A554	Chemical Munitions and Chemical Combat Support	4817	5731	6675	6374	Continuing	Continuing	Not Applicable	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Union of Soviet Socialist Republics (USSR) has developed and continues to improve upon its formidable chemical warfare capabilities. These capabilities represent a threat to the survival of US (and North Atlantic Treaty Organization (NATO)) Forces. US policy requires a program to counter/deter that threat by exploitation of state-of-the-art concepts and creation of a broad technology base to support development of a selective retaliatory chemical response capability. This project supports that need by providing for the technology base to support chemical munitions (binary lethal and incapacitating) and chemical combat support materiel (smoke, and civil disturbance/tactical irritant) development. Specifically, this project applies the results of basic research to the exploratory development of previously mentioned chemical munitions and chemical combat support weapon systems in meeting stated Army requirements. Additionally, the Army has been designated the Executive Agent for RDTE of chemical weapons and chemical-biological defense materiel for the Department of Defense (DoD). As such, there is a need for a project to support DoD-wide requirements in chemical weapon systems development. This project provides for such support.

C. BASIS FOR FY 1980 RDTE REQUEST: To provide technical support to binary chemical munitions development to assure the safest and most efficient/least risk munition development and determine scale-up to munition parameters for selected intermediate volatility or highly persistent agents for weaponization purpose. Continue exploratory development of light weight mobile binary systems, investigation of concepts for bulk mixing techniques and modular munitions, evaluation of potential new (improved) binary agents, and search for practical methods for field assessment of simulants. Develop analytical quality control standards for new binary chemical intermediates and determine the long-term stability and compatibility of new binary chemical intermediates for munitions design and shelf-life purposes.



Program Element: #6.26.22.A Title: Chemical Munitions and Chemical Combat Support  
 DoD Mission Area: #135 - Chemical-Biological Warfare Budget Activity: #1 - Technology Base  
 Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
ROUTE Funds (as shown in FY 1979 submission)	3220	5231	4601	Continuing	Not Applicable

Increased funding in FY 1978, FY 1979, and FY 1980 is to support: (1) the full implementation of the Army's Executive Agent responsibilities for chemical warfare (CW) ROUTE for all Services under Department of Defense (DOD) Directive 5160.5; (2) increased technology efforts in smoke and obscurants and; (3) a minimum level of effort for incapacitating agents and civil disturbance/tactical irritant agent development.

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.26.22.A

DoD Mission Area: #135 - Chemical-Biological Warfare  
Technology Base

Title: Chemical Munitions and Chemical Combat Support  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: This program supports the entire Department of Defense (DoD) chemical technology base on which development of chemical/retaliatory and combat support weapons depends. It addresses in-depth exploratory investigations in the following areas: (1) Lethal Chemical Agents/Weapons: Encompasses applied research activities associated with physical and analytical chemistry of potential lethal chemical systems; exploratory development of binary lethal chemical agents of various degrees of volatility to be used with a variety of munitions types with a resultant capability for air or ground delivery using standard and advanced weapons systems; and applied research leading to an understanding of phenomena which enhance the threat and effectiveness of these agents; (2) Incapacitating Chemical Agents/Weapons: Includes searches for new, more potent, incapacitants with shorter onset time and predictable effects and duration, percutaneously active, and very safe to handle; developing effective means for exploitation of these agents; and identifying the physical and chemical characteristics of these agents; (3) Chemical Combat Support Systems: Includes accelerated search for improved multi-spectral smoke/aerosol screening materials and delivery systems to cover visual through microwave regions of the electromagnetic spectrum; and provides for large area screening capability with minimum logistics burden. Also included are the development and evaluation of new chemical compounds for civil disturbance control and tactical irritant agents, development of concepts for their use and the establishment of feasibility of munitions responsive to the concepts. This effort originally consisted of 6.26.19.A, Chemical Combat Support and 6.26.20.A, Chemical Munitions Technology. These efforts were incorporated into 6.26.22 (single program element funding).

G. RELATED ACTIVITIES: Investigations under this project provide the essential exploratory effort in lethal, incapacitating, and civil disturbance control agents and munitions and the total technology base for the entire Department of Defense; no comparable work is done by the other Services, and coordination is maintained with them through Joint Agreements, liaison and correspondence to assure provision of the technology essential to their development needs. Also, close coordination is maintained between the investigative groups to preclude duplicative effort through joint working and coordinating groups. Coordination and cooperation is maintained with the United Kingdom (UK), Canada, and Australia. Related technical investigations are conducted under PE 6.27.06, "CB (Chemical-Biological) Defense and General Investigations".

H. WORK PERFORMED BY: Contractors - Ash Stevens Inc., Detroit, MI; Stanford Research Institute, Menlo Park, CA; National Library of Medicine, Washington, DC; Dugway Proving Ground, Dugway, UT; Ballistic Research Laboratory, Aberdeen Proving Ground, MD; In-house developing organization - US Army Chemical Systems Laboratory, Aberdeen Proving Ground, MD.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Over the past 20 years, virtually no systematic exploratory effort was expended in screening smoke materials. In contrast to this inactivity, a variety of flame and incendiary, lethal chemical, and civil disturbance control agent munitions systems have been developed and fielded. Two incapacitating agent munitions were developed and

Program Element: #6.26.22.A  
DoD Mission Area: #135 - Chemical-Biological Warfare  
Technology Base

Title: Chemical Munitions and Chemical Combat Support  
Budget Activity: #1 - Technology Base

fielded. In the late 1960's, the binary concept, to enhance safety and security in the field, has been applied successfully to development of artillery chemical projectiles. Searches for an intermediate volatility agent which loss the potential for both respiratory and percutaneous effects using the binary concept are now being conducted. In the incapacitating agents and weapons area, a compound (EA1834) which is quick acting at low concentrations has been discovered and evaluated. Based on assessment of the expected threat, a high urgency was placed on development of new multi-spectral large area smoke/aerosol screening agents. In 1976 and 1977, a five-year program for this purpose was prepared and initiated. Test facilities were modified to enable measurement of screening characteristics of standard and new screening agents. All US standard smokes were characterized and tests of promising new materials for infrared screening were begun. New techniques for area screening and rapid dissemination started. Several unique foreign smoke formulations have been evaluated. Feasibility studies of establishing a computerized smoke technical data bank were completed. Work was started to measure the refractive index of known smoke ingredients. In FY 1977, the following accomplishments were made: synthesized and evaluated new chemical intermediates for EA5365 a candidate intermediate volatility agent, and conducted stability studies on neat and stabilized samples as well as mixtures of the proposed intermediates; assessed both insoluble and soluble polymers as thickening materials to increase stability of present chemical agents and conducted field dissemination tests with simulants, which resulted in Polyisobutyl Metacrylate (PIBM) being selected as an additive to the chemical intermediate QL; laboratory tested an alternative dye as a simulant for large scale munition dissemination firing; conducted area coverage studies; evolved design concepts for application of the binary system to lightweight mobile systems and conducted tests to assess projectile ballistic dynamic stability for various quantities of liquid fills and mixing characteristics in the 8-inch/130 millimeter extended range projectile; fabricated and evaluated two binary lethal agent rocket warhead concepts and determined the toxicities of intravenously administered percutaneous compounds related to EA5365. In FY 1978 the chemical systems laboratory: continued technological support for XM736 Binary VX projectile and evaluation of binary intermediate volatility agent (IVA) data base for further exploitation; completed thickened binary VX agent studies on clothing penetration and surface persistency; continued search for new binary lethal agents with greater effectiveness through clothing; and provided support for evaluation of current US capabilities, including viability of stockpile, to assess the need for new lethal chemical agent munitions.

2. FY 1979 Program: Complete technology support for XM736 Binary VX projectile and provide technical support to other munitions development; determine scale-up to munition parameters for selected intermediate volatility, or highly persistent agent for weaponization purposes; complete exploratory development of lightweight mobile systems; continue investigation of concepts for bulk-mixing techniques; evaluate new drone system as delivery vehicles; continue evaluation of potential new binary agents; devise practical means for field assessment of simulants and develop analytical quality standards for new binary chemical intermediates for better means of munition evaluation and control of raw materials; and determine long-term stability and compatibility of new binary chemical intermediates for munitions design and shelf-life estimation.



Program Element: #6.26.22.A

DoD Mission Area: #135 - Chemical-Biological Warfare  
Technology Base

Title: Chemical Munitions and Chemical Combat Support  
Budget Activity: #1 - Technology Base

3. FY 1980 Planned Program: Evaluate potential dual purpose (inhalation and skin penetration) chemical agents with emphasis on their adaptability to the binary mode for several candidate munition systems (e.g., missile and rocket warheads, drones, and modular munitions); continue to search for safe reactive simulants for binary agents and practical means for field assessment of these simulants for use in lieu of open-air agent testing; continue search for improved multispectral screening compounds and compatible dissemination systems; continue smoke aerosol characterization studies; complete concept formulation for improved infrared (IR) screening munitions and initiate concept studies for battlefield smoke elimination; complete toxicity effort (literature search, and preliminary, acute and subchronic toxicity evaluations) for candidate smokes; complete evaluation of Agent EA4923 for potential civil disturbance and tactical irritant use; continue studies of Agent EA3834 to determine its effectiveness as a percutaneous incapacitating agent. There are 98 personnel supported; of which 78 are professional.
4. FY 1981 Planned Program: Continue evaluation of potential dual purpose lethal agents adaptable to the binary mode; complete exploratory development of lightweight mobile binary lethal agent system; continue evaluation of chemical agent manufacture process and reactive simulants for use in testing munition parameters; conduct solvent agent optimizing studies for incapacitating agent EA3834; continue development of the technical data base on candidate smokes with emphasis on environmental effects and development of optical characteristics and elimination techniques for smokes; continue smoke toxicity studies and weaponization studies for incapacitating and civil disturbance agents.
5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.2/01.A

DoD Mission Area: #126 - Communications-Electronics

Title: Communication-Electronics

Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
AI92AA	Frequency Engineering and Optimization	0	350	1000	1400	Continuing	Not Applicable
AI92AE	System Engineering	0	0	500	560	Continuing	Not Applicable
AI92BA	Integration						
AI92BB	Military Computer Family	305	385	648	1530	Continuing	Not Applicable
AI92BC	Software Techniques	375	400	1850	1039	Continuing	Not Applicable
AI92BD	Teleprocessing Design Center	636	520	479	670	Continuing	Not Applicable
AI92BE	Intelligent Terminal Family	100	470	450	955	Continuing	Not Applicable
AI92BF	Communicative Technology	25	1054	2114	711	Continuing	Not Applicable
AI92CA	System Management Engineering	25	145	340	191	Continuing	Not Applicable
	Electromagnetic Compatibility	350	300	300	400	Continuing	Not Applicable
AI92DA	Technology						
	Communication System Design	0	0	300	450	Continuing	Not Applicable
AI92FA	Facility						
	Army Digital Distribution	1241	992	1109	1650	Continuing	Not Applicable
AI92FB	System (ADIS)						
	Signal Processing	0	0	300	300	Continuing	Not Applicable
AI92MA	Enhancements						
AI92MB	Fiber-Optics Communication	1764	2156	1450	1100	Continuing	Not Applicable
	Millimeter-Wave and	717	360	1727	1400	Continuing	Not Applicable
	Microwave Technology						
AI92NA	Tactical Antenna Technology	0	0	350	350	Continuing	Not Applicable
AI92NB	High-Frequency Communications	0	125	225	400	Continuing	Not Applicable
	Technology						
AI92SM	Switching Technology	0	0	158	250	Continuing	Not Applicable
AI92TA	Terminal Devices	0	0	0	106	Continuing	Not Applicable

Program Element: #6.27.01.A

DoD Mission Area: #126 - Communications-Electronics

Title: Communication-Electronics

Budget Activity: #1 - Technology Base

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The major thrust in the area of automatic data processing (ADP) is to develop and transfer technology advances in computer sciences for near term cost and quality improvements for both Department of Defense (DOD) weapons and ADP systems. This program area is coordinated under the Joint Service Research and Development (R&D) Technology Panel to the Office of the Secretary of Defense (OSD) Management Steering Committee for Embedded Computer Resources (MSEC-ECR). As such, it is responsive to DOD-wide deficiencies, including an absence of standardized computer architectures and languages, resulting in excessive automated system development and maintenance costs. The program focuses specifically on the provision of common software tools to enhance programmer efficiency, and the establishment of standardized advanced computer architecture, equipments, and programming languages. This program also supports development of the communications-electronics technology base required to meet the mission needs of the next generation of tactical communications systems. The problems which limit the capabilities of current communications equipment to be solved include excessive weight, size, power drain, crosstalk, Electromagnetic Pulse, and Electronic Countermeasures threat, reliability, and low channel capacity. The present system of metallic wire line communications requires costly, bulky inventories of coaxial and multi-pair cables which can be overcome through replacement by fiber-optics communications systems. Catastrophic microwave component failures can be overcome by development of a phased array antenna amplifier system with integral redundancy. Army does not have a digital distribution system to accommodate fire control and command and control system data exchange which cannot be efficiently transmitted with existing communication facilities.

C. BASIS FOR FY 1980 RDTE REQUEST: Major contractual effort will exploit recent technical advances in fiber-optics for cost-effective, high capacity communications and develop tactical millimeter radars and advanced microwave techniques for low intercept communications; support the development of the Army Digital Distribution System (ADDS) by use of packet radio and associated testbed experimentation; support the development of the Military Computer Family so as to ensure the availability of a family of common interoperable computers, and the Department of Defense Standard High Order Language (DOD-HL) program; support electro-magnetic compatibility (EMC) in order to keep pace with new and advanced communications systems; support tactical computer and software development to enhance performance and utilize the tremendous capabilities of microprocessors to improve communications; and develop high frequency communications as backup to vulnerable satellites, start new areas in tactical antennas, frequency optimization, and system integration.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Not Applicable
RDTE						
Funds (as shown in FY 1979 submission)	5698	7257	6950	Continuing		



Program Element: #6.27.01.A

DoD Mission Area: #126 - Communications-Electronics

Title: Communication-Electronics

Budget Activity: #1 - Technology Base

The reduction in FY 1978 was due to minor reprogramming actions to satisfy urgent, high priority requirements. The FY 1980 Budget request reflects redirection and expansion of the program in accordance with the latest Army priorities. A new start will commence in the area of spectrum optimization to resolve the increased problem of frequency management that has developed as new and more sophisticated communication systems are fielded. A new start in the area of system integration and communications system design to insure that future command and control systems are adequately supported with the required communications and that they will meet the national objective of rationalization, standardization, and integration (RSI). In the automatic data processing (ADP) area; intensified efforts in the area of communicative technology to develop information delivery systems for training purposes, new thrusts in developing Military Computer Family (MCF) compatible software products and tools, and increased experimentation in computer systems interoperability contribute to the increased funding requirements.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.01.A

DoD Mission Area: #126 - Communications-Electronics

Title: Communication-Electronics  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: Automation and Communications are rapidly becoming significant facets of almost every Army Defense System. The project goal is to provide technologies that will reduce the cost of development and support of tactical automation and communication functions, and to accelerate the fielding and improve the survivability of all Army systems in which automation and communication play major roles. Automation offers the potential for fielding systems with greater responsiveness, capacity, and accuracy, while at the same time reducing the human burdens. The increased use of automation, however, has created problems in the areas of software cost and performance, testing, proliferation of incompatible products (computers, terminals, peripheral devices, languages, software tools), reliability and cost of input/output devices, and potential inability to provide the required support of automation (hardware, software, people), after deployment. The approach in automation is to provide technologies for common interoperable families of (1) computers, (2) transportable software products and tools (including a common high-order language), (3) intelligent input/output devices (terminals, displays, auxiliary memories, etc.), and for systems engineering/integration, and test beds for system validation experimentation and integration/interoperability testing. Present communications technology does not meet today's Army needs. Problems of excess weight, size, power drain, crosstalk, Electromagnetic Pulse (EMP) and Electromagnetic Computer (EMC) threat, reliability, and low channel capacity require application of advanced technology. The current approach in communications is to develop new concepts, methods, and techniques needed for future Army Communication-Electronics (C-E) system and requires exploration of the following: fiber-optic and millimeter wave (MMW) communication, Electromagnetic (EM) wave generation, amplification, and modulation for line of sight and troposcatter; techniques for handling, multiplexing, and storing information; electromagnetic compatibility, system technology, net communications to exploit latest state-of-the-art with emphasis on antennas and High Frequency (HF) communications, packet radio and related technologies for the evolving Army Digital Distribution System (ADDS), switching technology, spectrum optimization, and information acquisition and processing (speech, print, picture).

G. RELATED ACTIVITIES: This program provides the exploratory development needed to support the following: Program Element 6.37.07.A (Communications Development); Program Element 6.37.22.A (Tactical Operations System); Program Element 6.37.23.A (Command Control); Program Element 2.80.10.A (Joint Tactical Communications Program (TRI-TAC)); and Program Element 6.32.07.A (Aircraft AVIONICS equipment). Other related research and studies performed by the Air Force and Navy are also considered. Coordination to avoid duplication of effort is accomplished by reviews conducted by Department of Defense through the exchange of technical reports and attendance at scientific meetings and conferences. Portions of the fiber-optics communications development moved into Program Element 6.37.07.A during FY 1979.

Program Element: #6.27.01.A

DoD Mission Area: #126 - Communications-Electronics

Title: Communications-Electronics

Budget Activity: #1 - Technology Base

H. WORK PERFORMED BY: 11T, Roanoke, VA; Norwalk, CT; SRI International, Menlo Park, CA; M/TRE Corp., McLean, VA. Twenty-seven other contracts will be awarded during FY 1980 with a total value of \$8,240,000. In-house developing organizations are US Army Communications Research and Development (R&D) Command, Fort Monmouth, NJ; US Army Communications Command, Ft. Huachuca, AZ; US Army Test and Evaluation Command, Aberdeen Proving Ground, MD; US Army Combined Arms Center, Ft. Leavenworth, KS; US Army Signal School, Ft. Gordon, GA; and Department of the Army (DOD) Electromagnetic Compatibility Analysis Center, Annapolis, MD.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Completed contract to develop form, fit, and function specifications for the Military Computer Family (MCF). Coordinated with the US Army Materiel Development and Readiness Command (DARCOM), United States Air Force (USAF), and Navy to general a tri-Service Memorandum of Agreement for MCF. Developed and tested new applications and variations of intelligent terminals. Enhanced work recognition systems relative to man/machine methodologies. Used the teleprocessing design center to establish a baseline for Tactical Fire Direction System (TACFIRE) and Tactical Operating System (TOS<sup>2</sup>) interoperability, including integration of both military and commercial components. Started final design of DOD common language and plans for first DOD-1 Compiler. Participated with other services and North Atlantic Treaty Organization (NATO) for computer resource management. Additional program development resulted in fielding of three maintenance information systems. Completed fabrication of interference susceptibility instrumentation and MIL-STD 220 revision. Supported drafting of the Army's position for the 1979 General World Administrative Radio Conference. Demonstrated feasibility for fiber-optics (FO) in several major tactical communications systems. Established concepts and efforts to provide a rugged six fiber optic (FO) cable to FO systems. Initiated component development of longer wavelength sources and detectors to improve the nuclear hardness and transmission performance of FO systems. Fabricated the development model of long haul FO Transmission Set AN/GAC-1 and started performance qualification tests. Started contract to develop high strength cable and high speed dispenser for over-the-hill guided missiles. Finalized communication link for FO missile system. Completed study to assess secure FO vulnerability. Signed memorandum of understanding between US Army Training and Doctrine Command (TRADOC)/Defense Advanced Research Projects Agency (DARPA)/US Army XVIII Airborne Corps to formulate concepts for Army Digital Distribution System (ADDS) requirements. Procured packet radios and hardware for the ADDS testbed. Continued experimental planning and investigation of ADDS testbed interfaces. Started contract for ten command post millimeter radios to replace cables in Europe. Expanded millimeter program to include Mobile Intercept Resistant Radios (MISER). Placed a computerized millimeter radio test facility into operation. Started contracts to develop scale models of distributed microwave antenna array and to improve the digital data link reliability of troposcatter radio.

2. FY 1979 Program: Maintain MCF coordination with industry and tri-Service requirements advisory committees. Award contracts for MCF architecture planning. Accomplish acquisition of MCF terminals/peripherals and system producibility integration with emphasis on microprocessor/computer design. Continue efforts on insertion, operating, and interoperability. Develop simulators and scenarios for remote systems and complete DOD language design. Continue participation in computer re-source panels in the area of communicative technology; and award contract for maintenance information delivery system.



Program Element: #6.27.01.A

DoD Mission Area: #126 - Communications-Electronics

Title: Communication-Electronics

Budget Activity: #1 - Technology Base

Investigate technology to provide secure communication via Advanced Research Projects Agency Network (ARPANET). Plan automated support of tactical spectrum managers and provide tech support to national and international frequency allocations/regulations. Plan upgraded testbeds/data bases for North Atlantic Treaty Organization (NATO) force model Electromagnetic Communications (EMC) vulnerability analysis. Start conduct for Intra-System EMC Measurement Technology and Instrumentation (M&I) Study. US Army Testing and Evaluation Command (TECOM) will contract for EMC susceptibility measurements as part of the effort to up-grade the existing EMC military standard. Provide EMC design guidance to project managers, develop criteria for EMC control standards, prepare model requirements for frequency optimization studies, and improve propagation loss models. Extend EMC technology base to spread spectrum systems. Continue support of Army Digital Distribution System (ADDS) testbed with emphasis on tactical deployment problems. Start user evaluation tests addressing Tactical Fire Direction System (TACFIRE)/Sensors scenario. Complete procurement of experimental packet radios for ADDS testbed. Continue design/fabrication of interfaces for ADDS testbed equipments. Complete performance qualification tests of long haul Fiber Optics (FO) transmission set and phase into engineering development under Project Manager, Army Tactical Communications Systems (PH, ATACS). Complete of several related FO missile payout tasks. Complete first phase of secure FO cable system. Start contract for a helicopter deployment system (expendable cable). Complete longer wavelength source and detector component development for FO. Complete foliage penetration/camouflage tests of new Mobile Intercept Resistant Radios (MISER). Conduct field tests of millimeter wave radios to replace cables for US Army Europe applications. Develop MISER radios for tank applications. Complete and test scale model microwave solid-state phased array. Start state-of-the-art study in High Frequency (HF) communications technology. Formulate HF development plan with contractual support to attack problem areas.

3. FY 1980 Planned Program: Implement system architecture in accordance with Military Computer Family (MCF) product planning. Coordinate with industry and tri-Service advisory committees. Develop concept methodology regarding specifications and microprocessor/microcomputer standards for MCF compatible terminals and peripherals. Continue technology investigations for MCF. Refine Department of Defense (DOD) common language. Continue development of management policies, techniques, and standards for computer sources. Plan optimum use of spectrum (1980-85) based on Electronic Counter-Countermeasures (ECOM) technology and threat. Equip NATO 1980-85 force models for EMC/Vulnerability analysis. Develop spectrum automated support model/testbed US/NATO effort. Continue support of frequency allocation regulations. The new start in system integration will establish extent of needed information exchange between and among tactical data systems and users. Engineer optimal electro-mechanical interconnections. Document and publish system integration findings for Army-wide review. Start contract to develop EMC instrumentation for frequencies above 40 GHz. Develop engineering criteria to extend EMC standards to 300 GHz. Continue work in frequency optimization, propagation loss, and spread spectrum EMC model. Continue ADDS testbed support and finalize deployment concepts with user community as applications arise. Continue plans and interface work to integrate Army systems into the ADDS testbed. Start investigation to extend ADDS to Brigade forward communications using conventional VHF-FM net radios. Develop ultra low loss FO cable assemblies. Start retrofit of longer wavelength sources and detectors into FO long haul system. Start work on multiple access/distributed multiplexing for local and long haul FO high data rate systems. Complete second phase of secure FO cable system. Test MISER radios for tank-to-tank applications. Start contract for a multichannel millimeter-wave (MMW) radio. The microwave contracts will cover adaptive transmission techniques.

Program Element: #6.27.01.A

DD Mission Area: #126 - Communications-Electronics

Title: Communication-Electronics

Budget Activity: #1 - Technology Base

solid-state high power amplifiers and spectrum efficient modulation techniques. Start antenna technology development using the results from the FY 1979 Antenna Project. Complete High Frequency (HF) development plan and prepare specifications and start contracts for initial investigations. Start technology support for the Communication System Design Facility. The number of personnel involved during this year is 57 professional and 15 support.

4. FY 1981 Planned Program: Continue coordination support for Military Computer Family (MCF) and with industry and tri-service requirements advisory committee. Continue other development efforts in MCF. Investigate tactical computer system technologies for validation and verification of insertion and interoperability. Continue developments in secure networks, software, standards, management policies, and procedures. Evaluate the North Atlantic Treaty Organization (NATO) force models and continue the frequency allocation support. Determine interpretation and translation needs regarding information exchanged between tactical data systems. Engineer functional translation apparatus and integrate into appropriate data systems. Continue Electromagnetic Compatibility (EMC) instrumentation contract started in FY 1980. Continue the EMC modeling programs and support to the project managers. Continue Army Digital Distribution System (ADDS) testbed support activity emphasizing user/developer activity leading to a preliminary ADDS operational concepts and requirements. Coordinate with National Security Agency (NSA) for secure ADDS network. Demonstrate ADDS extension to Brigade using tactical radios. Demonstrate multichannel use for ADDS extension. Start contract to investigate polymeric optic fibers for short distance links. Complete systems integration of longer wavelength sources and detectors into the long haul fiber optic (FO) system. Complete survey phase of FO multiple access/distributed multiplexing. Start contract to accomplish vulnerability assessment of the secure FO cable. Field test tuneable Mobile Intercept Resistant Radios (MISR) radios in tank and artillery scenarios. Field test the MISR mast/tripod radio at command posts. Develop low cost compact millimeter wave repeaters for command post range extension. Complete the microwave contracts. Assess the potential of emerging antenna technologies and devise methods of applying them to the solution of tactical antenna system problems. Investigation of areas defined during FY 1980 but not implemented contractually, will be awarded during FY 1981. Complete the design plan to implement the entire local Communication System Design Facility within Ft Monmouth, NJ. Award contract for installation of Design Facility system control, monitoring, and interconnection, and start initial preparation of expanded Design Facility accommodations and install a patching facility all within the US Army Communications Research and Development Command (CORADCOM) at Ft. Monmouth, NJ. Start work in Switching Technology with a functional analysis and redefinition of requirements at a large communications switching node. Start in-house and contractual work to determine an efficient software structure for a packet switched system. Start Terminal Device Work with efforts to investigate materials methods and devices for development of a lightweight facsimile scanner. NOTE: Current plans anticipate the breakout of the computer/automatic data processing areas into a different program element.

5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6,27.03.A

DoD Mission Area: #123 - Search and RSTA

Title: Combat Surveillance, Target Acquisition and Identification  
Budget Activity: #1 - Technology Base

A. RESOURCE (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs	Not Applicable
DM93	Combat Surveillance Target Acquisition and Identification	3977	5239	3658	4435	Continuing	Not Applicable	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides the technology base for new concepts and advanced systems for the solution of presently unsolved surveillance, target acquisition, and identification requirements. These include developing modular radar componentry to reduce size and cost, and to increase performance and reliability; non-cooperative battlefield identification friend or foe; radar techniques to identify stationary targets, penetrate foliage, and provide an all weather capability; passive acoustic techniques to rapidly locate hostile artillery; and integrating target acquisition sensors to provide fused intelligence output. It identifies the most promising alternatives to fill existing operational gaps in the Army's integrated surveillance, target acquisition, and identification capability. Exploratory development is performed in the following technological areas: personnel and vehicle detection; identification friend or foe (IFF); data transmission; weapons location; detection and measurement of nuclear radiation and bursts; photographic techniques; and the application of multi-beam antenna technology for integrating intelligence, surveillance, and target acquisition (ISTA) sensors.

C. BASIS FOR FY 1980 RDTE REQUEST: Complete exploratory development of the Surveillance and Target Acquisition Radar for Tank Location and Engagement (STARTLE). This radar will be installed on the Army's main battle tank for target location and engagement under poor visibility conditions. Work will be performed on lightweight modular radar componentry amenable to low cost quantity production; stationary target detection and identification; noncooperative Battlefield IFF; electronically steerable multi-beam antenna for long range ISTA sensor data transmission; multi-static radar; and an automated linear base acoustic artillery locating system. Suitability of radar as an all visibility surveillance and target acquisition sensor for anti-armor weapons will be investigated. Testing of low cost prototype radiation dosimeters and radiometers will continue.



Program Element: #6,27,03,A

DoD Mission Area: #123 - Search and RSTA

Title: Combat Surveillance, Target Acquisition and Identification

Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>	<u>Additional to Completion</u>	<u>Total Estimated Cost</u>
RDTE					
Funds (as shown in FY 1979 submission)	4240	5239	6160	Continuing	Not Applicable

Due to reorganization of the US Army Electronics Command into the US Army Electronics Research and Development Command and two other commands and transfer of the low energy laser technology mission from the Combat Surveillance and Target Acquisition Laboratory to the Night Vision and Electro-Optics Laboratory, funding of low energy laser technology efforts has been moved from this Program Element to Program Element 6,27,09.A - Night Vision Investigations beginning in FY 1980. FY 1978 decrease is due to funding transfer to other higher priority programs.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.03.A

Title: Combat Surveillance, Target Acquisition and Identification

Budget Activity: #1 - Technology Base

DoD Mission Area: #123 - Search and RSTA

F. DETAILED BACKGROUND AND DESCRIPTION: This project funds the exploratory development performed by the Combat Surveillance and Target Acquisition (CSTA) Laboratory. Major areas of emphasis are weapons location technology with emphasis on a passive automated linear base acoustic artillery counterfire target location system to replace the current manual system; investigations in intelligence, surveillance and target acquisition (ISTA) sensor data transmission with the objective of reducing vulnerability to detection and jamming, reducing radio frequency spectrum requirements, eliminating relays, and reducing size, weight and cost; development of radar techniques for the detection, classification and identification of stationary non-firing targets under all visibility conditions; development of a family of lightweight, low cost, common radar modules amenable to quantify production which will dramatically lower life cycle costs of future radar systems because of resulting commonality in logistics, maintenance, and training requirements; development of a low cost, multi-purpose, tactical radiation measurement device which will perform the functions presently requiring several separate devices; development of small format, tactical photo equipments and of photo processing and exploitation equipments; investigation of the suitability of radar as an all visibility surveillance and target acquisition sensor for anti-armor weapons; noncooperative battlefield IFF; and development of a radar to enable the Army's main battle tank to engage targets under conditions of poor visibility.

G. RELATED ACTIVITIES: Related development is performed by the Navy and Air Force. Work is coordinated during reviews conducted by the Office of the Under Secretary of Defense for Research and Engineering, through inter-laboratory visits and communications, attendance at specialized scientific meetings and conferences, inter-service liaison, technical reports, and the Annual Tri-Service Radar Symposium. Additionally, the Army and the Defense Advanced Research Projects Agency (DARPA) are participating in a joint program to find new or improved solutions in the hostile weapons location and radar netting areas in Program Element 6.27.26.A. Due to transfer of the low energy technology mission from the Combat Surveillance and Target Acquisition Laboratory to the Night Vision and Electro-Optics Laboratory, funding of low energy laser technology efforts has been moved to Program Element 6.27.05.A - Night Vision Investigations.

H. WORK PERFORMED BY: In-house work is performed by the US Army Electronics Research and Development Command at Fort Monmouth, NJ. Contractors include Harris Corporation, Melbourne, FL; Rockwell International, Anaheim, CA; Martin-Marietta, Orlando, FL; Texas Instruments, Dallas, TX; Georgia Institute of Technology, Atlanta, GA; RCA, Princeton, NJ; Hughes Aircraft, Culver City, CA; Motorola, Scottsdale, AZ; AIL Division Cutler Hammer, Deer Park, Long Island, NY; Malibu Research Associates, Santa Monica, CA; Oak Ridge National Laboratory, Oak Ridge, TN; Honeywell Incorporated, Minneapolis, MN; Santa Barbara Research Center, Santa Barbara, CA; and United Technology, Norwalk, CT.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Prior technological efforts have resulted in type classification and procurement of the AN/PPS-5, AN/PPS-15, AN/TPQ-36, and AN/TPQ-37 radars, the AN/GVS-5 Laser Rangefinder; and full scale development of the AN/PAQ-3 Modular Universal Laser Equipment and AN/AAS-32 Airborne Laser Tracker. The design and exploratory development of a

Program Element: #6.27.03.A

Title: Combat Surveillance, Target Acquisition and Identification

Budget Activity: #1 - Technology Base

DoD Mission Area: #123 - Search and RSTA

miniaturized, low cost, laser Mini-Range-finder and a lightweight foliage penetration radar have also been completed. Hardware fabrication and software development of the Environment and Radar Operation Simulator (EROS), which simulates the environmental inputs and signal processor parameter of surveillance radars, have been completed and EROS has been applied to the design of a netted radar intrusion detection system being developed by the Air Force for the Missile-X System. During FY 1978 two experimental low power, high capability Charge Coupled Device (CCD) radar signal processors were developed. Two contracts for competitive exploratory development designs and prototypes of the Surveillance and Target Acquisition Radar for Tank Location and Engagement (STARTLE) were awarded. The ability of the radar portion of a radar/laser hybrid to handoff targets with sufficient accuracy to meet narrow field-of-view electro-optic device requirements was successfully demonstrated. Development of a solid state radar receiver/transmitter common module was initiated. Development of a low power, moderately fast frequency hop synthesizer was completed and the technology was transferred to full scale development in the Army's Remote Battlefield Sensor System (REMBASS) program. Development of a wideband frequency hopping adaptive antenna array transmitter/receiver for intelligence, surveillance and target acquisition (ISTA) sensor data transmission requirements continued. The feasibility of detecting stationary military targets in ground clutter and classifying such targets into categories such as weapon and non-weapon through analysis of their radar signatures was demonstrated. Evaluation of a prototype silicon diode neutron dosimeter was completed. An initial prototype model of a Battlefield IFF was completed and tested. Fiber optic technology for hardened fieldable communications systems continued as did efforts on the precision target location and weapons delivery capabilities of lasers. The Position and Attitude Monitor (PAM) effort was completed and plans to integrate PAM in a Weapons Acquisition Sensor Platform (WASP) for advanced laser surveillance system applications were initiated.

2. FY 1979 Program: Continue technological support of ongoing developmental programs. Monitor ongoing prototype development under the STARTLE contracts. Fabrication of an exploratory development model of the Anti-Armor Surveillance and Target Acquisition Radar (ASTAR) will continue. Tests with ASTAR will be conducted to demonstrate the tracking of multiple targets and simulated target handover to an anti-armor weapon system. Evaluation of two previously developed CCD radar signal processors and development of the solid state radar receiver/transmitter common module will continue. Investigation into the suitability of multistatic radar for combat surveillance and target acquisition will be initiated. The effectiveness of stationary target detection and classification technique will be expanded from two class to multi-class recognition; and performance improvements obtainable with multiple looks will be investigated. Evaluation of the wideband frequency hop adaptive antenna array transmitter/receiver for ISTA sensor data transmission will be made in a high electronic countermeasures (ECM) environment. Evaluation of an exploratory development model of a digital constant bandwidth compression unit will be made. Development of a wideband, electronically steerable, multiple beam antenna will be initiated. This antenna will permit longer range, multiple reception and transmission of ISTA sensor data while providing increased anti-jam protection and operation over a broader radio frequency band. System parametric analysis of an automated linear base acoustic artillery locating system will be conducted. Evaluation of a prototype low cost lithium fluoride gamma radiation dosimeter and fabrication of various cadmium telluride radiation detectors will begin. Complete technology transfer of long-life injection laser/advanced detection modules to first generation fiber optic communication systems. Continue laser wavelength diversity common module efforts. Continue efforts on laser



Program Element: #6.27.03.A

Title: Combat Surveillance, Target Acquisition and Identification

DoD Mission Area: #123 - Search and RSTA

Budget Activity: #1 - Technology Base

beamrider/beacon module for advanced guidance systems. Laser/radar hybrid efforts will continue. Initiate effort to develop laser heterodyne/homodyne base technology for surveillance, target acquisition and weapons delivery.

3. FY 1980 Planned Program: Continuation of the FY 1979 program. Transfer of technology developed for Surveillance and Target Acquisition Radar for Tank Location and Engagement (STARTLE) to advanced development will occur. Fabrication of an exploratory development model of Anti-Armor Surveillance and Target Acquisition Radar (ASTAR) will be completed and field tests demonstrating its suitability as an anti-armor surveillance and target acquisition sensor for advanced anti-armor weapons will be conducted. Work will begin on a modular radar signal processor using the previously developed Charge Coupled Device (CCD) radar signal processors as a baseline. Investigation of tactical multi-static radar will continue. Parameters for a stationary target classifier will be selected and classifier performance evaluated through simulation. Application of stationary target detection and classification techniques to noncooperative Battlefield Identification friend or foe (IFF) will be investigated. Evaluation of the exploratory development model of a digital constant bandwidth compression unit will be completed and development of the wideband, electronically steerable, multiple beam antenna will continue. Development of an automatic signal detection and recognition capability for the automated linear base acoustic artillery locating system will begin; fabrication of exploratory development models for field testing will be initiated; and design parameters for a microphone detector array will be defined. Evaluation of the low cost lithium fluoride gamma radiation dosimeter and fabrication of various cadmium telluride radiation detectors will be completed. Gallium arsenide and mercury iodide radiation detectors will be evaluated. Exploratory development of a device using color photography for near real time target detection, location, and identification will commence. A total of 17 professional and 4 support personnel are involved in this program element.

4. FY 1981 Planned Program: Continuation of the FY 1980 Program. Continue efforts on stationary target detection and classification, noncooperative Battlefield IFF, common radar modules and tactical multi-static radar. Complete development of the wideband, electronically steerable, multiple beam antenna and initiate development of an exploratory development model of a wideband solid state Ku band amplifier for intelligence, surveillance, and target acquisition (ISTA) sensor data transmission requirements. Continue development of the automated linear base acoustic artillery locating system and define parameters for a state-of-the-art surface acoustic wave (SAW) array processor to support system advanced development. Initiate a new effort to permit identification and location of enemy nuclear munitions on the battlefield. Initiate a new effort to develop the critical technology essential in the development of a multi-purpose, multi-beam antenna which will enable one system to perform the functions of radar, jamming, data transmission and reception, and detection and direction finding of enemy emissions, all in a high electronic countermeasures environment.

5. Program to Completion: This is a continuing program.

FY 1980 ROTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.04.A  
DoD Mission Area: #134 - Environmental Sciences

Title: Military Environmental Criteria Development  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual 3040	FY 1979 Estimate 3307	FY 1980 Estimate 3559	FY 1981 Estimate 4099	Additional to Completion Continuing	Total Estimated Costs Not Applicable
AF25-01	Analytical Systems Technology	857	489	1114	1054	Continuing	Not Applicable
AF25-02	Standards Development	745	880	1030	1100	Continuing	Not Applicable
AF25-03	Decontamination Technology	1438	1938	1415	1962	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program was established in FY 1977 to provide exploratory development of new Technology in support of the Project Manager for Chemical Demilitarization and Installation Restoration. The current program priority is in support of prevention of contaminant migration from Rocky Mountain Arsenal (RMA), Denver, CO. In addition, emphasis is being directed toward development of analytical methods, standards and process technology for application at Army ammunition plants, and installations declared excess to military needs. The technical thrusts of the program are: development of analytical techniques for identification and quantification of contaminants; research to characterize contaminants, determine their toxicities and provide data for the establishment of realistic standards by regulatory agencies; and development of containment/decontamination technology to meet established standards. Technology developments will support containment/decontamination efforts at other Department of Defense installations as problems are identified and plans are approved.

C. BASIS FOR FY 1980 ROTE REQUEST: To continue efforts to improve analytical methodology for application at Rocky Mountain Arsenal (RMA) and other restoration projects; to complete feasibility studies for containment of pollution sources and to evaluate alternative methods for source elimination; to complete testing and evaluation of final design criteria for boundary water containment/treatment system at RMA to comply with the State of Colorado's cease and desist orders; to develop alternative soil and water treatment processes for pollutants found during containment surveys; to develop analytical methodology for identification and quantification of contaminants found in soil, water, process disposal facilities, and biological tissues; and to perform toxicological studies for development of environmental standards at selected Army installations.

Program Element: #6.27.04.A  
DoD Mission Area: #134 - Environmental Sciences

Title: Military Environmental Criteria Development  
Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Costs	Not Applicable
RDTE Funds (as shown in FY 1979 submission)	3040	3307	3600	Continuing		

The \$41K decrease in FY 1980 resulted from reduced efforts in development of decontamination technology.

E. OTHER APPROPRIATION FUNDS: Not Applicable



Program Element: #6.27.04.A

DoD Mission Area: #134 - Environmental Sciences

Title: Military Environmental Criteria Development  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: Increasing public and national interest in the environment, coupled with the progressive encroachment of civilian communities to the borders of previously isolated Army installations, have created growing concern about the potential threat posed by the steady movement of groundwater contaminants to the borders of the installations and beyond. As a result of military, Congressional and public interest in such contamination at Rocky Mountain Arsenal (RMA) direction was provided by the Assistant Secretary of the Army for Installations, Logistic and Financial Management (ASA(1, L&F)) to establish a comprehensive program for correcting the total Army problem. Responsibility for this program was assigned to the Project Manager for Chemical Demilitarization and Installation Restoration (PM CDIR) and a charter was approved by the Secretary of the Army on 22 August 1975. An overall plan of approach to the problem was developed by PM CDIR, which involves three principal phases, namely: Installation Assessment, Technical Systems Development and Decontamination Operations. The RDTE funded part of this plan applies primarily to the Technical Systems Development phase. Other phases of the plan will be accomplished with Operation and Maintenance, Army (OMA) and Military Construction, Army (MCA) appropriations. The Technology effort consists of three technical areas: Analytical Systems Technology, Standards Development (establishment of environmentally acceptable levels of tolerance for each contaminant), and Decontamination Technology. A detailed plan for addressing contamination problems at Rocky Mountain Arsenal (RMA) was established and work is in progress. In addition, effort is directed toward establishing acceptable standards for concentrations of pollutants by performing chemical and toxicological studies for Army peculiar pollutants when such standards are not available. Further, evaluation of existing technology and development of new technology is performed when necessary, to include associated decontamination methods to control migration of pollutants and analytical methods to support these efforts.

G. RELATED ACTIVITIES: Conduct of the Installation Restoration (IR) program involves extensive interface with a significant number of other Government agencies. These include, but may not be limited to, Department of State, Health, Education and Welfare, Agriculture, Transportation, Interior, US Nuclear Regulatory Commission, Environmental Protection Agency, National Academy of Sciences, Department of Defense (DOD) Explosives Safety Board, and state and local governments. On 23 July 1976, the Department of the Army was designated as the lead services for the compilation and refinement of applicable technology, and the development of new or improved technology and criteria or standards for the DOD installation restoration program as it relates to all contamination, including chemical, biological and radiological. This mission was assigned to the PM CDIR. A concept plan has been developed for the coordination of the required effort between the Army, Navy, and Air Force.

H. WORK PERFORMED BY: In FY 1980 approximately 29% of the funding will be assigned to the U.S. Army Medical Bioengineering Research & Development Laboratory, Ft. Detrick, Frederick, MD, for toxicology testing of chemical contaminants leading to the establishment of standards; approximately 6% of the dollars will be assigned to Chemical Systems Laboratory and Product Assurance Directorate, US Army Armament Research and Development Command, APG, MD, primarily to assist in developing advanced techniques for sampling, analyzing, handling and storage of contaminated samples. The balance of the RDTE program resources (65%) will be used for development of decontamination process technology, in support of Rocky Mountain Arsenal, Denver, CO, and other selected sites. It is estimated that approximately 61% of the total program in FY 1980 will be in contracts, 3 percent will be assigned to Government agencies outside the Army and 36% will be used for in-house effort performed at Rocky Mountain Arsenal, Denver, CO, and the Waterways Experiment Station, Vicksburg, MS.

Program Element: #6.27.04.A

DoD Mission Area: #134 - Environmental Sciences

Title: Military Environmental Criteria Development  
Budget Activity: #1 - Technology Base

1. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: This program element was established in FY 1977. A detailed plan for control of off-post migration of chemical pollutants at Rocky Mountain Arsenal (RMA) was prepared. An Analytical System Working Group, composed of chemists from other Army agencies, was established to recommend analytical schemes, a Quality Control Plan (QCP) and required analytical instrumentation. The work by the Army Surgeon General to develop data needed to recommend environmental standards included evaluation of 22 top priority compounds. The Surgeon General's coring and analysis program involved the taking of 500 soil and 50 vegetation samples. Mammalian, aquatic, wildlife and vegetative toxicity studies were initiated on selected contaminants. Acute and subacute toxicity studies on Diisopropylmethyl Phosphonate (DIMP) and Dicyclopentadiene (DCPD) were completed and chronic toxicity studies were continued. The Surgeon General recommended temporary guidelines for DIMP and DCPD to the National Research Council in August 1976. Design criteria were established for an interim groundwater containment/treatment system for Rocky Mountain Arsenal (RMA) consisting of dewatering wells, a Bentonite barrier, a granular carbon absorption water treatment facility and a series of recharge wells. In FY 1977 analytical methods for five RMA groundwater contaminants were developed and automated in Quality Control Program. Temporary environmental guidelines for concentrations of DIMP and DCPD in drinking water based on toxicology testing were concurred in the National Research Council. Laboratory and bench scale water treatment studies led to the selection of a granular carbon absorption system to treat groundwater at the north boundary of RMA.

Major effort throughout FY 1978 was in support of the RMA project. In the Standards Development area, a third problem definition study on 13 additional contaminants found in RMA waters was completed and recommendations were rendered in September 1978. The DIMP/DCPD chronic toxicity study was continued. Soil, water, and tissue analysis methods were selected and implemented in March 1978. The North Boundary pilot containment/treatment system were installed with operations commencing in August 1978. These operations will support development of design criteria for an expanded system, if required, to fully satisfy the State of Colorado's cease and desist orders. In the area of source containment, feasibility studies to contain the waste materials in Basins F and A at RMA were initiated. Water treatment studies were continued involving both organic and inorganic removal techniques. Granular carbon absorption and ultra violet-ozonolysis processes were tested using waters both at the boundary and sources. The inorganic treatment focuses on fluoride removal and selection of a process in support of the pilot containment/treatment system was made in January 1978. Source treatment studies were limited to small laboratory scale characterization of Basin F contents as a prelude to bench scale treatment work.

2. FY 1979 Program: Support of the RMA and other selected projects includes work in all three major technical areas. In the Analytical Systems area, refinement and expansion of analytical protocols is continuing. Standard analytical reference materials (SARMS) of high purity and stability are being developed for pesticides being produced on arsenals and which are found in groundwater and soil. Identification of unknown contaminants in groundwater through gas chromatographs, mass spectrometry and other techniques is being continued. In the Standards Development area, problem definition studies initiated on eight additional compounds will be completed incrementally by August 1979. Subacute toxicity studies on three sulfur compounds is in progress and temporary guidelines will be recommended in January 1979. Chronic toxicity studies on DIMP and DCPD associated with the RMA project will be completed and final standards recommended in January 1979. A shortened protocol for toxicity testing has been developed and will be

Program Element: #6.27.04.A  
DoD Mission Area: #134 - Environmental Sciences

Title: Military Environmental Criteria Development  
Budget Activity: #1 - Technology Base

recommended for wider use in the standards development area in March 1979. In the area of decontamination technology, preliminary design criteria will be finalized for the expansion of the north boundary containment treatment system at Rocky Mountain Arsenal (RMA). Completion of a quantitative feasibility study for Basin A will provide decontamination preliminary design criteria. The granular activated carbon process for organic contaminated removal is being continued in a pilot status at RMA. An activated aluminum absorption process for removal of fluoride is being implemented in a pilot status. Development of an inorganic/organic combination groundwater treatment system for source waters is being pursued. Waste stream studies to be incorporated in a total system approach are continuing.

3. FY 1980 Planned Program: Increased effort will be directed toward the development of analytical methods for the identification and quantification of approximately 18 chemical compounds found in the soil, waters, process waste disposal facilities and biological tissues of organisms at nine Army installations scheduled for preliminary contamination surveys. Methods for extraction and preservation of samples, as well as the development of standard analytical reference materials for use in laboratory quality control and measurement will be developed. In the Standards Development area, problem definition studies, toxicity screening and follow-on toxicity studies will be performed on chemical compounds found in soil, water, process waste disposal facilities and biological tissues at the Army installations undergoing preliminary contamination surveys. Additionally, the 18 candidate compounds will undergo hazard analysis, three toxicity screens and one full-scale toxicity study using vegetation, mammals, wildlife, domestic and aquatic animals. Long-term containment material compatibility studies will continue for Basins A and F. Monitoring of the contract for development of ground penetrating radar will be finalized. Alternative techniques to granular activated carbon for removal of DDT will be explored. Testing processes such as ultra violet-ozonolysis will be initiated. Studies of enhanced leaching of migrating contaminants and soil treatment of less mobile pollutants will be initiated for possible cleanup of active sources. Techniques that apply in situ and excavated processing such as soil activation, chemical fixations and chemical neutralization/vegetative uptake will be screened for applicability. Twenty two (22) professional and three (3) support personnel will be required to pursue the FY 80 planned program.

4. FY 1981 Planned Program: Develop analytical methods for identification and quantification of approximately twelve additional chemical compounds found in soil, waters, process waste disposal facilities, and biological tissue of organisms from two Army installations scheduled for preliminary contamination surveys and three Army installations anticipated to be under full comprehensive contamination survey. In addition, development of analytical methodology for detection and quantitative analysis of degradation and process by-products from the decontamination process design efforts will be initiated. In the area of Standards Development, problem definition studies, toxicity screening and follow-up toxicity studies will continue on chemical compounds found in soil, waters, process waste disposal facilities and biological tissues. Some twelve new compounds will undergo hazard analysis, four toxicity screens, and two full-scale toxicity studies using vegetation, mammals, wildlife, domestic, and aquatic animals. In the area of Decontamination Technology, long term containment material compatibility studies will be completed for source isolation alternatives being constructed at RMA. In conjunction with three scheduled comprehensive surveys scheduled for FY 1981, interim containment measures will be refined and implemented in a pilot system design to stop off-post migration. Concurrent with the RMA expanded containment system process improvement, other treatment improvements will be processed. Leaching and soil treatment technology development will be refined as the data base resulting from the comprehensive survey expands. Limited laboratory studies



Program Element: #6.27.04.A  
DoD Mission Area: #134 - Environmental Sciences

Title: Military Environmental Criteria Development  
Budget Activity: #1 - Technology Base

of in situ containment/treatment techniques will be initiated. Water treatment studies will build upon technical data base from ongoing comprehensive surveys.

5. Program to Completion: This is a continuing program.

**FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY**

Program Element: #6.27.05.A  
DoD Mission Area: #121 - Electron Devices  
Title: Electronics and Electron Devices  
Budget Activity: #1 - Technology Base

**A. RESOURCES (PROJECT LISTING): (\$ in thousands)**

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>12578</b>	<b>13670</b>	<b>14720</b>	<b>16897</b>	<b>Continuing</b>	<b>Not Applicable</b>
AH9401	Microwave Tubes and Subsystems	1091	1510	1375	1910	Continuing	Not Applicable
AH9402	Pulse-Power Technology and Subsystems	1043	1040	1245	1275	Continuing	Not Applicable
AH9403	Displays and Peripherals	606	778	820	900	Continuing	Not Applicable
AH9404	Integrated Electronics	1488	1834	2395	2560	Continuing	Not Applicable
AH9405	Cost-Effective Micro-Electronic Modules	1357	1508	1974	1990	Continuing	Not Applicable
AH9406	Reliability	902	539	550	600	Continuing	Not Applicable
AH9407	Millimeter Wave Devices and Circuits	1119	1303	1495	2647	Continuing	Not Applicable
AH9408	Microwave Integrated Circuits	739	1219	1400	1365	Continuing	Not Applicable
AH9409	Acoustic Signal Processing Devices	1079	1027	1066	1420	Continuing	Not Applicable
AH9410	Frequency Control Devices	738	1252	1000	880	Continuing	Not Applicable
AH9411	Power Sources and Systems	1388	1360	1400	1350	Continuing	Not Applicable
AH9412	Electronic RAM Technology	300	100	0	0	Continuing	Not Applicable
AH9413	Advisory Group on Electron Devices	110	200	0	0	Continuing	Not Applicable
AH9414	Wire and Cable	618	0	0	0	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** This exploratory development program in electron devices and related materials technologies is resolving critical component barrier problems which are preventing performance, cost, size, weight, and reliability improvements in Army electronic equipment to meet specific enemy threats. This program will provide required increases in electron device performance; on this base, critical new and improved electronic systems concepts are being developed to insure

Program Element: #6.27.05.A  
DoD Mission Area: #121 - Electron Devices

Title: Electronics and Electron Devices  
Budget Activity: #1 - Technology Base

the technological superiority of our forces. Specifically, the program encompasses the development of selected basic electronic building blocks which pace the development of approximately 50 Army systems; included are integrated circuits, solid state devices, microwave tubes, power sources, millimeter components, frequency control, and display devices. These device developments are directly coupled to systems objectives in electronic warfare, night vision, communications, avionics, data processing, combat surveillance and target acquisition, guidance and fire control, navigation and position location, and missile technology.

C. BASIS FOR FY 1980 RDTE REQUEST: The FY 1980 program will continue to develop military types of ultra-high speed, large-scale integrated (LSI) circuits to effect 10-100 times improvement in cost and speed of low power digital electronics for: (1) secure command and control in an expected intense electronic warfare environment, (2) hostile weapons location, and (3) tactical signal analysis to determine nature and deployment of adversary forces. Microwave solid state device development will be continued to permit all types of communications to function in jamming environments, and radically new forms of microwave power tubes will reduce costs and improve efficiency beyond levels which now severely limit the development of stand-off and expendable jammers and airborne platform weapons location systems. Particular effort is required to develop low cost millimeter wave components for radars and target designator to "see and strike" through smoke and adverse weather. Millimeter devices are also needed for short range, secure, highly mobile battlefield communications and broadband electronic warfare receivers and jammers. Techniques will be pursued to produce, store, and deliver large packets of energy for laser weapons with potential application to particle beam systems. Effort will continue on devices to link the battlefield commander in real time to the tactical situation via high contrast, electroluminescent displays applicable to constrained spaces for mobile fire control. Safety features of the new lithium battery systems will be improved to provide a compact, reliable high energy portable source for combat operations over a wide temperature range. Also, thermoelectric generators will be developed for silent, maintenance-free operation (for Aircraft Beacons), and an advanced high precision, lightweight AC-to-DC power supply will be completed for use with critical digital equipment systems.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Not Applicable
	12700	13670	16026	Continuing		



Program Element: #6.27.05.A  
DoD Mission Area: #121 - Electron Devices

Title: Electronics and Electron Devices  
Budget Activity: #1 - Technology Base

Funding differences between Congressional Descriptive Summaries submitted last year (FY 1979) and this year are as follows:  
(1) FY 1978 planned (\$12,700) vs. actual (\$12,578) represents a reduction of \$122K. This reduction was due to minor reprogramming actions to satisfy urgent, high priority Army requirements. (2) FY 1980 (\$16,897 vs. \$16,026). This increase responds to guidance from the Office of the Under Secretary for Defense Research and Engineering for a program increase in the electronic devices area.

E. OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.27.05.A

DoD Mission Area: #121 - Electron Devices

Title: Electronics and Electron Devices

Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** This program represents the Army's prime source of funds for solving critical electronic component deficiencies in combat equipment/systems. It provides the technological base in electron devices and represents the future strength of the Army for developing new and improved electronic systems required to maintain the technological superiority of our forces. The technological gap between the US and the Communist Bloc has been closing very rapidly over the past several years. It is imperative that the funding for this Program Element be increased in order to exploit new breakthroughs and restore our lead in key device technologies. In this respect, this program is important to the nation, not only for its contribution to the national defense but also for its contribution to the commercial applications of the derived technology. Specifically, the program encompasses the development of the basic building blocks of all electronic equipment/systems, including integrated circuits, solid state devices, microwave tubes, power supplies, frequency control, display devices, and the development of electronic materials and processing innovations. Development is based on devices for the Army that are economical to produce, durable and simple to operate, adjust, and maintain. The program objective is to establish cost and performance feasibility of new device concepts by extension of the state-of-the-art to form a basis for advanced system development and better reliability. Device feasibility thereby established is basic to orderly development planning and the expanded technology base provides systems designers with the necessary new technical guidance and risk assessments to configure improved electronic systems for minimum total life cycle cost of ownership. Such coupling is provided for specific system needs in the application areas of electronic warfare, night vision, communications, avionics, data processing, combat surveillance and target acquisition, guidance and fire control, navigation and position location, and missile technology.

**G. RELATED ACTIVITIES:** Coordination is achieved with other Government agencies through the Department of Defense (DOD) Advisory Group on Electron Devices (AGED) and the Interagency Advanced Power Group. Interservice coordination and program cooperation are also directly derived from joint preparation of the Technology Coordinating Paper on Electron Devices, which assesses the technical program, goals, and potential payoff from the tri-Service total investment of electronics technology base funds.

**H. WORK PERFORMED BY:** The Electronics Technology and Devices Laboratory, Fort Monmouth, NJ. This laboratory is scheduled to use approximately 50 percent of the program funds contractually. The principal contractors are: P.R. Mallory, Burlington, MA; Watkins-Johnson, Palo Alto, CA; RCA, Burlington, MA; Somerville, Camden, Princeton, NJ; Power Conversion, Inc., Mt. Vernon, NY; IRW, Redondo Beach, CA; Hughes, Fullerton, Torrance, CA; Northrop, Des Plaines, IL; EG&G, Salem, MA; Varian, Beverly, MA; Raytheon, Waltham, MA; E-Systems, Falls Church, VA; Stanford, Menlo Park, CA; General Electric, Syracuse and Schenectady, NY; Rockwell International, Anaheim, CA; Westinghouse, Baltimore, MD; and Texas Instruments, Dallas, TX.

#### **I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

1. FY 1978 and Prior Accomplishments: In FY 1978 the Electronics Technology and Devices Laboratory was very successful in developing critically needed electronic devices, which will improve the Army's capability to see, fight, and communicate on the battlefield, in the following major thrust areas:

Program Element: #6.27.05.A

DoD Mission Area: #121 - Electron Devices

Title: Electronics and Electron Devices

Budget Activity: #1 - Technology Base

a. Microelectronic Devices - Successfully advanced microelectronic technologies to reduce design time and costs and increase circuit speed capability for command, control, and communication (C<sup>3</sup>) systems. Evaluated the efforts of semiconductor channel lengths on large-scale integrated (LSI) circuit yields and speed capability, and determined channel length requirements for agile frequency synthesizers for communications and remote battlefield surveillance (REMBASS) systems. Designed, fabricated, and demonstrated a modular packaged, expendable, smart, communications jammer. Developed a charge coupled device (CCD) technology for fabrication of high performance CCD filters and correlators with low on-chip power consumption for use in low cost radar electronic warfare (EW) spectral analysis and speed processors. Transferred internally developed low temperature, high pressure oxidation technology to industrial and university laboratories.

b. Microwave/Millimeter Wave Devices - Selected emitter infrared (IR) source to demonstrate necessary output extended band for aircraft self-protection equipment (ASE). Increased traveling wave tube (TWT) efficiency (20% to 30%) which reduces airborne critical prime power need from 1 kW to 0.67 kW. Established feasibility of all solid state transmitter for mini-remotely piloted vehicle (RPV). Increased S-Band bipolar transistor capability by factor of 6 for ballistic missile defense radar (35 watts).

c. Passive Devices - Breakthrough in high shock crystal technology made possible by in-house invented chemical polishing process for quartz; high shock crystals successfully tested at 20,000g; 230 prototypes supplied to Remotely Monitored Battlefield Sensor System (REMBASS) and cannon launched beam-rider projectile (CLBRP) contractors. REMBASS high shock oscillator assembly successfully tested at 15,000g; 88 engineering models supplied to REMBASS contractor. High shock REMBASS resonator mounting problem solved for required precision frequency control GPS transceivers. Developed and demonstrated a surface acoustic wave (SAW) chirp transform correlator capable of solving missile reentry problems for ballistic missile radar that requires processing of several nonlinear FM waveforms with processing gains up to 3600:1. Improved reliability of low cost plastic encapsulated semiconductor devices and circuits for limited military use.

d. Power Sources - The use of Lithium-SO<sub>2</sub> (1st generation) cells for high rate applications; i.e., transmit currents in transceivers and normal currents in night vision devices, has been impeded by the occasional occurrence of explosions when cells are subjected to forced discharge. The processes responsible for initiation and propagation of explosions have been tentatively identified and solutions to this program are being pursued. An increase in switching frequency from 20 kHz to 50 kHz has been achieved in the switch modulated direct current (DC)-to-DC power conversion process, thus improving equipment power density by a factor of 2X for power processors to be used in mobile digital communication-electronic systems.



Program Element: #6.27.05.A

DoD Mission Area: #121 - Electron Devices

Title: Electronic and Electron Devices

Budget Activity: #1 - Technology Base

2. FY 1979 Program:

- a. Microelectronic Devices - The program to obtain faster digital LSI signal processing speeds will be accelerated toward providing vastly more powerful signal-intelligence (SIGINT) and real time weapons location in lightweight, low power packages for ground mobile, RPV, and conventional airborne platform and to provide nonjammable surveillance and target acquisition data links. Specific component technologies to be developed include microfabrication to micron-peometry levels and use of gallium arsenide and CCD techniques to achieve multigigahertz high density, low power integrated circuits.
- b. Microwave/Millimeter Wave Devices - Development will continue on 95-140 GHz devices for antitank, mini-remotely piloted vehicles (RPV) radars, smart projectiles, guided missiles, beam riders, secure communications, and air defense systems--all having a smoke penetration and all-weather requirements. Needs include higher power, solid state oscillator sources, low noise mixers, low cost integrated circuit (IC) receivers, beam-steering antennas, and high energy pulsers. Low cost power tube technology will be transferred to production development for low cost airborne jammers.
- c. Passive Devices - Development will be continued on both surface acoustic wave (SAW) and quartz crystal frequency synthesizers and precision crystal units for covert, jam-resistant communication and data links. SAW programmable adaptive signal correlator and frequency synthesizer development will continue for real time generalized waveform processing with a goal of 10X reduction in cost over present techniques. Techniques will be explored to allow a tactical field operator to interact directly with the information presented on his display, thus eliminating several sources of operator error and significantly reducing his training time.
- d. Power Sources - The lithium-thionyl chloride electrochemical system with its potential for increasing the energy output of lithium primary cells by a factor of at least 50% will permit size and weight reductions essential for forward area manpack applications. An advanced thermoelectric generator will be designed giving silent operation, multifuel capability, a 50% reduction in fuel consumption, and a 70% reduction in infrared (IR) signature--critically needed to satisfy Army requirements for silent, low maintenance, portable power sources for forward area equipments.

3. FY 1980 Planned Program:

- a. Microelectronic Devices - A significant increase in gallium arsenide digital circuit technology development will be applied to high speed planar large-scale integrated (LSI) circuits to demonstrate results in specific electronic function needs of systems. In particular, a number of such LSI subsystems will be implemented in electronic warfare (EW) signal-intelligence (SIGINT) and electronics-intelligence (ELINT) real time signal processing applications. Emphasis will be placed on a single semiconductor chip subsystem approach to use of charge coupled devices (CCD's) for data sampling and signal processing, incorporating digital and analog interface circuitry for specialized EW, surveillance, and communication systems. The

Program Element: #6.27.05.A  
DoD Mission Area: #121 - Electron Devices

Title: Electronic and Electron Devices  
Budget Activity: #1 - Technology Base

optimum speed capabilities of second generation silicon-on-sapphire (SOS) technology (300 to 500 MHz) will be achieved and technology in sapphire fabrication advanced to elevate complementary metallic oxide (CMOS)/SOS to a mainstream cost competitive position.

b. Microwave/Millimeter Wave Devices - First generation 95 GHz systems will be completed and the efforts will be expanded to extend the frequency range up to 500 GHz for such applications as higher accuracy terminal homing for missiles and projectiles; solid state sources up to 400 GHz will be developed concurrently with low noise mixers and applicable integrated circuits. Beam scanning devices to replace plasma array antennas will be developed. Millimeter-wave imaging will be explored for smoke penetration. Microwave tube developments will aim at meeting updated radar, electronic warfare and communication requirements (e.g., imaging and foliage penetration radar systems, multioctave airborne electronic warfare (EW) jammers, and secure communication systems). Microwave and infrared (IR) decoy sources will be developed to protect Air Defense Systems from radiation seeking missiles. Nanosecond microwave and optical transmitters required by systems to locate nonfiring hostile weapons will be developed.

c. Passive Devices - Advanced signal processors using surface acoustic wave (SAW)-charge coupled device (CCD) technology will be exploited; these spread spectrum techniques will have a significant impact on improving secure jam-resistant tactical systems. Work on miniature molecular frequency standards will be intensified. Planned display programs can be expected to result in standardization of militarized display technologies incorporating the full range of necessary performance capabilities, thereby allowing more effective display logistics while providing optimum data communications at all levels of the battlefield situation.

d. Power Sources - Improved, low cost, reliable nickel-zinc rechargeable cells will be designed which double the energy density available with conventional nickel-cadmium or lead-acid) rechargeable cells (35 Wh/lb)--such low cost rechargeable batteries are required to support vehicular requirements and meet the need for reliable "float" batteries for emergency power and UPS systems. Feasibility of the advanced AC-to-DC power processor technique will be demonstrated by performance of an experimental 2.5 kW model which will replace present rotary types--which are becoming totally unsuited for modern military needs.

e. The number of personnel involved during this year is: 109 professional and 70 support.

#### 4. FY 1981 Planned Program:

a. Microelectronic Devices - Complete systems architecture for EW Adaptive Signal Sorter and develop receiver-synthesizer circuits for data links and communications. In FY 1981 start analogue/analog correlator: demonstrate 400 MHz receiver synthesizer circuits and initiate development of cryogenic cooled large scale integrated/very large scale integrated circuits (LSI/VLSI). Complete Computer-Aided Design (CAD) of selected high speed subchips (IC Modules) for EW systems. Complete ruggedization and cost reduction of hermetic hybrid microcircuits for artillery launched and air-dropped sensors and jammers.

Program Element: #6.27.05.A

DoD Mission Area: #121 - Electron Devices

Title: Electronics and Electron Devices

Budget Activity: #1 - Technology Base

b. Microwave/Millimeter Wave Devices - Initiate two-year K-Band Jammer Development. Start two-year development of one GHz jammer. Initiate three-year development of heated solid or gaseous 8-14 micron jammer source. Second year of three-year development of one kW millimeter (MM) radar tube package. Demonstrate plasma cathode switch - magnetic pulsers and miniature 100 kHz high voltage inverter power supply with CO<sub>2</sub> laser load for missile beam rider applications and with MM wave transmitters. Complete development of discrete devices (Gunn diodes, mixers) at 94 GHz and fabricate one integrated receiver at 140-300 GHz with active devices (oscillators, mixers) incorporated directly in low cost dielectric waveguide for RPV's/missile guidance/terminal homing.

c. Passive Devices - Complete development of surface acoustic wave (SAW) oscillator and fast frequency hopping synthesizer for spread spectrum application at microwave frequencies. Apply doubly-rotated cut to SAW devices to achieve vibration/temperature stability. Start design and construction of first compact packaged acousto-optic signal processing device for signal analysis. Complete development of a family of ceramic flatpack quartz crystal enclosures and processing technologies to permit production quantities of precision crystals with required stability for slow frequency hop single channel ground and airborne radio system (SINCGARS).

d. Power Sources - Second generation lithium cell design will be established and evaluated against high rate (high current) requirements of Laser Designator equipment. Develop 10 kW AC-to-DC high frequency switch modulation power processor for standardized module family for digital equipment. Develop high efficiency thermoelectric (TE) power source (using new TE materials) to increase performance from 175 to 300 watts per hour per pound of fuel.

5. Program to Completion: This is a continuing program.



FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.06.A

DDO Mission Area: #115 - Chemical-Biological Warfare Base  
Technology Base

Title: Chemical Biological Defense and General Investigation  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
	<u>TOTAL FOR PROGRAM ELEMENT</u>	<u>9656</u>	<u>12186</u>	<u>12543</u>	<u>12679</u>		
A553	Chemical/Biological (CB) Defense and General Investigations	9656	12186	12543	12679	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army, as the Department of Defense (DoD) Executive Agent, has responsibility for conducting a coordinated interservice RDTE program to provide the essential technology base upon which the Services can develop chemical weapons and chemical and biological defense (CW/CBD) systems on an individual or joint basis to meet their stated military operational needs. This program is designed to provide the interservice technology base for chemical/biological (CB) defense. Exploratory development is conducted to acquire a technological base to counter the threat posed by potential enemy agents/munition systems; to enhance all aspects of physical defense including warning, detection, identification, decontamination, individual and collective protection; to investigate compounds of military interest; to evaluate protection countermeasures, avoid technological surprise, and uncover leads for new retaliatory agents; and to study agents and methodology for the training of troops. The basic output is knowledge leading toward improvements in CB defense. This knowledge is also usable in advancing the retaliatory chemical agents/munitions technology.

C. BASIS FOR FY 1980 RDTE REQUEST: Program will include the completion of the exploratory development of the advanced chemical agent detector alarm (ACADA). Completion of exploratory development using eel enzyme for vapor detection in the M256 Chemical Agent Detector Kit and preparation of final exploratory development report will be accomplished. Evaluation of selected collection media for efficiency and stability with threat agents will be accomplished. Evaluation and development of the residual gas life concept for individuals, collective and body protection items will be continued. Comparative testing of prototypes for the field decontamination system will be completed and the best concept advanced to advanced development. Exploratory development of the decontamination effectiveness detector kit will be completed. Search for nontoxic chemical training agents will continue. Complete concept feasibility evaluation of the biological detection kit.

Program Element: #6.27.06.A

DoD Mission Area: #135 - Chemical Biological Warfare Base  
Technology Base

Title: Chemical Biological Defense and General Investigations  
Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
RDTE					
Funds (as shown in FY 1979 submission)	9611	9686	13091	Continuing	Not Applicable

The Army is the DOD Executive Agent for conducting chemical/biological (CB) Defense RDTE and, as such, has responsibility for a totally integrated tri-Service CB defense program. The increased funding in this program (FY79) allows the RDTE level of effort needed to support Service peculiar CB defense requirements such as CB defensive equipment for shipboard application. These Service peculiar requirements which have been identified since submission of the FY 1979 Congressional budget requests. There is a decrease in the FY 1980 funding request (i.e., FY 1979 vs FY 1980 submission) because exploratory development will be completed during FY 1980 on several key items (e.g., advanced chemical agent detection alarm, decontamination effectiveness detector kit and the biological detection kit) which started during FY 1978 and FY 1979.

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.06.A

BoD Mission Area: #135 - Chemical Biological Warfare Base  
Technology Base

Title: Chemical Biological Defense and General Investigations  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: This program supports the entire Department of Defense chemical and biological defense technology base and addresses in-depth exploratory activities in the development of a broad spectrum of equipment concepts for: point sampling and area chemical agent warning systems and detection, sampling and identification equipment; individual and collective protection against respiratory and percutaneous chemical agent hazards; filtration and purification of air and water; personnel and equipment contamination prevention and decontamination; chemical defense training; improvement of safety in military chemical industrial-type operations; airborne biological agent sampling, fractionation, and concentration for point sampling and area scanning-type agent detection and alarm systems; physical protection against and decontamination of biological agents. Program also includes investigations supporting both defensive and offensive development in chemical dispersion and dissemination techniques, chemical agent systems process chemistry and pilot operations; and searches for potential chemical agents and toxicology of chemical agents.

G. RELATED ACTIVITIES: No comparable work is done by the other Services. Coordination is maintained with the other Services (e.g., meetings, status reports) to assure provision of the technology base to meet their advanced and engineering development needs, adoption of joint service requirements where practicable, and preclude duplicative efforts. Coordination and cooperation is maintained with the United Kingdom, Canada, Australia, and with the North Atlantic Treaty Organization (NATO). Related technical investigations are conducted under PE 6.26.22, Chemical Munitions and Chemical Combat Support.

H. WORKED PERFORMED BY: In-house by US Army Chemical Systems Laboratory, Edgewood, MD. Contractors include Calspan Corporation, Buffalo, NY; Stanford Research Institute, Menlo Park, CA; Shock Hydraulics, North Hollywood, CA; University of Pittsburgh, Pittsburgh, PA; National Health Laboratory, Bethesda, MD; Midwest Research Institute, Kansas City, MO; Honeywell Incorporated, St. Petersburg, FL; and Ash Stevens Incorporated, Detroit, MI.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: During earlier years the technology base in chemical defense was expanded as follows:

- a. Completed exploratory development (XD) on ionization detector to enhance the sensing capability of the M8 Chemical Alarm System.
- b. Examined contamination avoidance techniques and decontamination methods applicable to tactical equipment.
- c. Identified two concepts for simplified collective protection filters.
- d. Demonstrated feasibility of a detector kit for chemical agents in water.
- e. Completed evaluation of threat posed by enemy thickened chemical agents. In FY 1978, the following were accomplished:
  - a. Investigated feasibility of laser remote sensing techniques for airborne chemical agents.
  - b. Recommended to user candidate decontamination materials and component concepts.
  - c. Conducted conceptual studies for simplified collective protection for field shelters and residual gas-life indicator for large area filters.
  - d. Completed exploratory development on the detector kit for chemical agents in water.
  - e. Published report evaluating foreign threat and vulnerability to toxic agents.



Program Element: #6.27.06.A

DoD Mission Area: #135 - Chemical Biological Warfare Base  
Technology Base

Title: Chemical Biological Defense and General Investigations  
Budget Activity: #1 - Technology Base

2. FY 1979 Program: The FY 1979 program will: demonstrate the feasibility of simplified collective protective system to include new concepts for solving the entry/exit problem; continue to assess effectiveness of US chemical agent detection systems against all potential threat agents; continue process studies on candidate training agents; complete design, fabrication, and testing of a remote sampling and analysis system; maintain a continuing program for assessing the potential of foreign agents; conduct studies in techniques for increasing the burning rates of pyrotechnic/agent systems; and continue to synthesize sufficient quantities of compounds of interest to the various programs for advanced toxicological, chemical and weaponization studies. Continue exploratory development of the advanced chemical agent detector alarm (ACADA) and M256 chemical agent detector kit using the eel enzyme detection method.
3. FY 1980 Planned Program: Complete exploratory development of an advanced chemical agent detector alarm (ACADA). Complete exploratory development (XD) for chemical agent vapor detection in the M256 Chemical Agent Detector Kit using eel enzyme and preparation of final report; evaluate selected collection media for efficiency and reliability with threat agents; continue evaluation and development of the residual gas life concept for individual, collective and body protection filters; complete comparative testing of prototypes for improved decontamination systems and move the best concepts into advanced development; complete XD of the decontamination effectiveness detector kit; continue search for nontoxic chemical training agents; and complete concept feasibility evaluation of the biological detection kit. The total number of professional personnel required to support this program is 125 and the total number of support personnel required is 31.
4. FY 1981 Planned Program: Continue to assess effectiveness of protective systems (e.g., advanced field chemical lab and the decon detector kit) to all potential threat agents and effectiveness of chemical agent detection systems against potential threat agents in all tri-service environments. Initiate and/or continue process studies on training agents as required. Continue acquisition of data on the internal hazard in contaminated vehicles operating in contaminated environment.
5. Program to Completion: This is a continuing program.

# FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.07.A Title: Mapping and Geodesy  
 DoD Mission Area: #134 - Environmental Sciences Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	4904	4200	4524	4400		Not Applicable
A855-A	Geodetic & Positioning Technology	1066	912	931	1527	Continuing	Not Applicable
A855-B	Topographic Mapping Technology	1433	1590	1429	1077	Continuing	Not Applicable
A855-C	Military Geographical Analysis Technology	1408	1698	2164	1796	Continuing	Not Applicable
A855-D	Army Terrain Information System (Artins)	997	0	0	0	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program investigates and develops methods and equipment to provide the Field Army and Department of Defense with a more responsive, cost-effective capability for collecting, processing, displaying and disseminating geodetic, topographic and military data and products to satisfy tactical and strategic needs of the Army & DOD for accurate and near real-time position, azimuth and evaluation data and terrain information in support of military operations.

C. BASIS FOR FY 1980 RDT&E REQUEST: FY 1980 support to Defense Mapping Agency includes: Continued development of a vehicle-mounted rapid gravity survey system; development of digital techniques for imagery data extraction and elevation determination; and use of holographic and other coherent optical techniques for image data extraction. FY 1980 program support to Field Army includes: gyroscopic azimuth devices for artillery survey application; low-cost optical inertial techniques for rapid collection of accurate positional data; improved map designs and production procedures for tactical operations and planning; imagery correlation facilities for near-real-time targeting and positioning; advanced methods and materials in support of baseplant and field map reproduction; and experimental instruments for remotely measuring stream velocity, depth and width for river crossing operations.

Program Element: #6.27-07.A  
DoD Mission Area: #134 - Environmental Sciences

Title: Mapping and Geodetic  
Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Total Estimated Costs	
				Additional to Completion	Not Applicable
	4904	4200	4615		

The \$91K decrease in FY 1980 resulted from funding needs of higher priority DA projects causing a reduction in research effort on development of geodetic and positioning technology.

E. OTHER APPROPRIATION FUNDS: Not Applicable



Program Element: #6.27.07.A  
DoD Mission Area: #134 - Environmental Sciences

Title: Mapping and Geodesy  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: Program develops new or improved means for rapid acquisition, processing, and dissemination of positional information, mapping data and military geographic information. End items directly support future map production activities affecting strategic and tactical deployment of forces and weapons systems. Program covers areas of Geodesy and Point Positioning, Mapping and Geographic Analysis, and provides exploratory development portion of the technology base for both the Army and Defense Mapping Agency (DMA). Techniques and equipment developed include: (a) improved position-location data for long-range weapons employment; (b) improved mapping of critical world areas; and (c) mapping, military geographic information (MGI) and terrain analysis for Army tactical operations to include contingency, limited war, general war and rescue operations.

G. RELATED ACTIVITIES: Applies results of basic research performed under Project 852C, Mapping and Geodesic Research, Program Element 6.11.02, Defense Research Sciences. Both Air Force and Navy have related mission-oriented research, which is coordinated with the Army's program by the Defense Mapping Agency (DMA) and the Under Secretary of Defense for Research and Engineering (USDRE). Advanced and engineering development of techniques and equipment resulting from this program are accomplished under the following program elements. DMA Program Element 6.37.01.B, Mapping, Charting and Geodesy Investigation and Prototype Development; DMA Program Element 6.47.01.B, Mapping, Charting and Geodesy Engineering Development and Test; Army Program Element 6.37.12.A, Mapping and Geodesy; and Army Program Element 6.47.16.A, Mapping Geodesy.

H. WORK PERFORMED BY: Approximately 61% of the work is performed in-house at the U.S. Army Engineer Topographic Laboratories (USAETL), Ft. Belvoir, VA. The balance is performed by commercial contractors or other government agencies. Total contractual effort for FY 80 will be \$1.749M. The five major contractors are: Xerox Electro-Optical Systems, Pasadena, CA; Litton Industries, Woodland Hills, CA; DBA Systems Inc., Melbourne, FL; University of Kansas, Lawrence, KA; Perkins-Elmer, Danbury, CT. There are 9 additional contracts totaling \$272K. Other government agencies funded by this project include: Rome Air Development Command, Rome, NY; Electromagnetic Compatibility Analysis Center, Annapolis, MD, and the Small Business Agency. The latter supports minority business activities.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: State-of-the-art study of gradiometer technology was completed, and design of an integrated inertial/gradiometer system initiated in support of Defense Mapping Agency (DMA) strategic missile requirements. Development and field testing of the optical model Remote Stream Measuring Device for use by Military Engineers was completed. In the Development of Multi-Image Interpretation techniques, a hardware update contract was completed on the Texture Analysis/Image Processing Module, and work was performed on developing procedures for analog/digital processing of Factor Map Overlays as required for special maps products and terrain analysis operations in support of Field Army needs for terrain information. Work was completed on the generation of a new symbol file for incorporation into the advanced development graphics. Studies were performed to develop a simplified, all-weather distance/azimuth measuring instrument with automatic read-out for use in Artillery Survey for Weapons Systems. Work was performed in-house to develop a variable-geometry laser printer in support of DMA baseplant printing requirements. Contractual studies in Optical/Digital Radar Simulation were completed, with results evaluated for application to the PERSHING II missile program.

Program Element: #6.27-07.A  
DoD Mission Area: #134 - Environmental Sciences

Title: Mapping and Geodetic  
Budget Activity: #1 - Technology Base

2. FY 1979 Program: Design concepts for an Integrated Rapid Gravity Survey System (RGSS)/Gradiometer system are being evaluated for use by the Defense Mapping Agency (DMA) in strategic missile planning. Contractual efforts are being performed to fabricate and test prototype advanced gyros and integrated/optical distance measuring equipment. In-house efforts are continuing in the development of digital data extraction techniques to include advanced digital correlation methods and techniques for matching dissimilar images for use by DMA in speeding the mapping process by automation. Additional software is being procured, modified and tested on the Digital Image Analysis Laboratory (DIAL) Facility leading to an all-digital pass point selection/correlation system. Fabrication of the prototype Remote Stream Measuring Device (Non-Optical) will be completed and testing and evaluation begun. Work will be completed on the Radar scene simulation and studies performed in-house and by contract to demonstrate the feasibility of new hybrid (optical/digital) processing techniques, in support of the Perishing II and Remotely Piloted Vehicles.
3. FY 1980 Planned Program: Components of an Integrated Rapid Gravity Surveys System (RGSS)/Gradiometer System will be evaluated. Fabrication of a prototype advanced gyro will be completed and delivered for laboratory and field evaluation. Exploratory development of an all-weather, automated distance/azimuth measuring instrument will be completed and a plan for advanced development initiated. Tactical Terrain Intelligence Application computer software development will be continued and demonstrated. Advanced electronic digital image processing techniques feature extraction tests will be concluded, a final report prepared and a proposal for design of a follow-on digital feature extraction system will be submitted. Efforts aimed at developing accurate image quality evaluation procedures will be completed. Evaluation of the Remote Stream Measuring Device (Non-Optical) will be completed. Results will be documented and used to support proposed follow-on Advanced Development. A contract will be awarded to investigate state-of-the-art techniques for optically processing aerial imagery and to compare optical and digital approaches in terms of speed, resultant accuracies and hardware costs. The in-house personnel required to support the program include 59 professionals and 5 support.
4. FY 1981 Planned Program: Procure, test and evaluate a gravity gradiometer. Develop and test/validate advanced gyroscopic and distance measuring equipment for field Army surveying. Develop small, low-cost stereo compiler to upgrade the Topographic Support System (TSS). Demonstrate capabilities of automated feature extraction system and draft documentation for follow-on advanced development. Develop digital image processing software to enhance capabilities of in-house Digital Image Analysis Laboratory. Develop automated procedures to assess image quality of materials used in map compilation. Initiate contractual development of prototype mass graphics storage system.
5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.09.A

DoD Mission Area: #121 - Electron Devices

Title: Night Vision Investigations  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs	Not Applicable
<b>TOTAL FOR PROGRAM ELEMENT</b>		<u>5362</u>	<u>6063</u>	<u>9183</u>	<u>11940</u>			
DI95	Night Vision Investigations	5362	6063	9183	11940	Continuing		Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army has a need for a cost effective ability to fight during periods of darkness and limited visibility with a relative combat capability that is equal to that of day. This program element supports the development of technology to ensure the US maintains its lead in the ability to acquire and engage targets under all battle-field conditions. This combat capability is required to counter the threat of a foe that plans and trains to continue combat operations during periods of darkness and limited visibility. Using advanced technologies and new concepts in the field of electro-optics this program develops new techniques, components, and devices that will result in significant cost reductions and performance improvements for night vision devices.

C. BASIS FOR FY 1980 RDT&E REQUEST: Funds requested provide for research and exploratory development to improve performance effectiveness, simplify, and reduce life cycle costs of future night vision systems. Major efforts will be in the areas of Visionics, Thermal Imaging, and Lasers. Visionics - Continue development of tactical search and target acquisition models to determine least costly techniques for satisfying requirements. Models will be upgraded to incorporate the adverse effects of camouflage, atmospheric conditions, and countermeasures based on data collected during field experiments. Thermal Imaging - Continue development of second generation forward looking infrared (FLIR) devices with a ten-fold increase in sensitivity for penetration of obscuration, e.g., fog, smoke, dust. Develop technology base for third generation infrared systems and multispectral imagers which will have greatly improved performance over present systems. Continue development of uncooled thermal detectors to eliminate the need for cryogenic or thermoelectric coolers. Conduct further research into lightweight electro-optical sensor and target seekers for use in terminal homing of smart munitions. Laser - Begin development of a laser battlefield identification Friend or Foe (IFF) system. Develop Carbon Dioxide (CO<sub>2</sub>) lasers to provide for penetration of obscuration equal to that of infrared systems. Integrate these lasers with heterodyned forward looking infrared to form an all weather target sensing system. All of these efforts are pointed toward improving the Army's ability to acquire and engage targets under all weather conditions.



Program Element: #6.27.09.A  
DoD Mission Area: #121 - Electron Devices

Title: Night Vision Investigations  
Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>	<u>Additional to Completion</u>	<u>Total Estimated Costs</u>
ROUTE Funds (as shown in FY 1979 submission)	4850	6063	5623	Continuing	Not Applicable

Increase in FY 1978 (\$512) was for movement of facilities and equipment into the new laboratory building at Ft Belvoir.  
Increase in FY 1980 requests are due to transfer of Laser technology from 6.27.03 to this program element (\$2000) and fabrication of technology demonstrators under this program element instead of 6.37.10 (\$1560).

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.09.A

DoD Mission Area: #121 - Electron Devices

Title: Night Vision Investigations

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: This effort covers exploratory research and development of components, techniques, and man/machine models, and environmental data bases essential for both significant cost reductions and performance improvements in night vision electro-optical devices. The Visionics program is primarily concerned with the development of tactical effectiveness models, the refinement of a target signature data base, and the exploitation in technology demonstrator configuration of new sensor ideas and concepts. The performance and field utility of sensors for both direct acquisition and weapons system applications are studied using analytical models. Results from these models are the basis for engineering judgements of technological concepts prior to hardware development. Models are used to portray realistically the performance of the various sensors on the active battlefield against various threat weapon systems. These simulation models include both the "man in the loop" and automatic features for unmanned applications. Far infrared thermal imaging technology is directed toward fabrication and initial testing of second generation Forward Looking Infrared (FLIR) and the Surveillance Target Acquisition Radar for Tank Location and Engagement (STARTLE). A new generation of high performance FLIR systems is being developed which uses high density, Charge Coupled Device (CCD) focal plane arrays. The CCD effort seeks to double the standoff range of present FLIR in airborne applications and greatly enhance the performance of combat vehicle FLIR under conditions of poor visibility. Increased search effectiveness is provided by automatic target cueing and image enhancement techniques. Large two dimensional staring focal plane arrays which integrate the CCD signal processing with 8-12 micron detectors offers significantly improved system sensitivity while reducing mechanical and optical complexity. Prototype demonstrator systems are the Advanced Tactical (ATAC) FLIR for the Advanced Attack Helicopter and the High Sensitivity Tank FLIR (HISTAF). The concept of a common module carbon dioxide laser and definition of a family of compact modular elements compatible with FLIR is being developed. Applications of this laser family include range finders, battlefield IFF, beamrider missile guidance, target designators, and wind sensors. Common modules and interface elements for integration with FLIR are constructed and tested. Because of the noncommercial aspects of night vision and electro-optical technologies, it is essential to maintain internal research and development activity.

G. RELATED ACTIVITIES: Close coordination is maintained with the Navy, Air Force, and Marine Corps to avoid duplication. Through the Joint Logistics Commanders (Army, Navy, and Air Force) coordinating groups have been established to ensure that maximum use is made of limited assets, e.g., the Navy is developing 8-14 micron 2d generation infrared detectors while the Army is developing those sensitive to 3-5 micron energy. The Army has responsibility for the Configuration Management of the 1st Generation Thermal Imaging Common Modules used by all Services. In addition, an active international program of technical cooperation is maintained with many countries, particularly those of the National Atlantic Treaty Organization (NATO) and the Quadrilateral countries (America, Britain, Canada, Australia).

H. WORK PERFORMED BY: Night Vision Laboratory, Fort Belvoir, VA. Representative contractors are: Philco Ford Corporation, Aeronutronics Division, Newport Beach, CA. Martin-Marietta, Orlando, FL; Hughes Aircraft, Culver City, CA; and Texas Instruments, Dallas, TX.

Program Element: #6.27.09.A

DoD Mission Area: #121 - Electron Devices

Title: Night Vision Investigations

Budget Activity: #1 - Technology Base

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Second generation image intensifiers tubes have been developed and are now in production. Gallium arsenide photocathode technology for third generation intensifiers was investigated and prototypes with greatly increased sensitivity have been demonstrated. An advanced pyroelectric vidicon has been demonstrated. In the Visionics Area Models to predict range of intensifier and visual search performance were completed, and techniques established to include the effects of smoke and target signature variation on the evaluation of electro-optical viewing systems. Programs were initiated to develop a flat panel helmet mounted display for use by helicopter pilots, and a miniature camera tube for possible use in Remotely Piloted Vehicles (RPV's). A 2d generation Thermal Imaging program to demonstrate high density detector focal planes, up to 2000 detectors, was initiated. Uncooled, high performance infrared (IR) imagers were evaluated for applications such as driving through smoke and fog.
2. FY 1979 Program: Far Infrared: High performance silicon detectors will be fabricated for long range helicopter and armored vehicle use. Miniature Devices: Evaluate 3d Generation Gallium-Arsenide Photocathode/Charge Coupled Device (CCD) intensification tube for use in the Remotely Piloted Vehicle (RPV) television camera, and fire and forget missiles. Evaluate lightweight, flat panel, helmet mounted pilots display, and holographic one tube (HOT) goggle. Fabricate nonscanning, thermoelectrically (TE) cooled, staring focal plane (3d generation thermal) sensor, for possible application in automatic tracking imaging for smart munitions in the mid-1980's.
3. FY 1980 Planned Program: Continue development of 2d generation Forward Looking Infrared (FLIR) and advanced concepts to penetrate smoke and foul weather to acquire targets. Development will be continued on concepts for smart sensor-seekers for terminal homing of munitions. Continue development of 3d generation thermal imagers. Initiate development of 10.6 micron laser and heterodyned forward looking infrared systems (FLIR's) which will be integrated into an all weather target sensing system. This program element supports the work of 89 civilian professional and support personnel.
4. FY 1981 Planned Program: Continue development of 2d generation FLIR's for helicopter and armor/antiarmor applications with ranges compatible with increased missile ranges, 10.6 micron lasers, heterodyned FLIR for foul weather penetration, and 3d generation thermal imagers. Begin development of a high reliability, low cost, lightweight, nonscanning thermal system for use with fire and forget missiles and other self-guided munitions.
5. Program to Completion: This is a continuing program.



FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.15.A  
DoD Mission Area: #122 - Electronic Warfare Technology  
Title: Tactical Electronic Warfare Technology  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT						Not Applicable
A042	Tactical Electronic Warfare Technology					Continuing	Not Applicable
A904	Tactical Electronic Warfare Techniques					Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supplies the exploratory development technology in support of all Army Electronic Warfare (EW) programs. Technologies from voice frequencies through radar and optics are utilized to provide new concepts of countermeasures (CM) and counter-countermeasures (CCM). Technological advances are urgently needed to support development/fielding of electronic/signals warfare equipments. Present size, weight, location accuracy, limited output power, and sophisticated signal processing techniques are some of the many system characteristics which must be solved by modern technology to ensure the use of the frequency spectrum to friendly forces while denying its use to the enemy. The rapidly increasing use of precision guided weapons necessitates a corresponding effort in the detection and countering of such threats. Investigation and development is continuing to insure that the latest developmental US missiles, communications, electronics, and night vision systems will function satisfactorily in a hostile CM environment.

C. BASIS FOR FY 1980 RDT&E REQUEST: Major technology thrusts will be pursued in the following areas:  
threat warning and CM's against electro-optical guided or aided weapons; the achievement of optimum jamming modulations to counter weapons systems associated communications and non-communications systems; and, in conjunction with the US Air Force, and Navy develop jamming mission system techniques. These goals will be pursued primarily through a continuation of work initiated in prior years.  
defeating radars will be optimized and the development of jamming sources will continue.  
The effectiveness of various jamming techniques against missiles will be evaluated, improved jamming sources

Program Element: #6.27.15.A

DoD Mission Area: #122 - Electronic Warfare Technology

Title: Tactical Electronic Warfare Technology

Budget Activity: #1 - Technology Base

designed, and threat warning techniques investigated. The feasibility of fully automatic electronic countermeasures (CM) for protection from laser guided weapons will be established and efficient laser jamming sources developed. Improve jamming antenna with matching unit. Techniques to increase resistance to jamming of communications systems will concentrate on the jamming antenna with matching unit. Conduct various modulation effectiveness measurements against to microwave data links. In an effort to optimize jamming modulations that will provide a minimum jamming to signal ratio and effectively utilize the effective radiating power (ERP) of existing and future radar jammers. Evaluate high power communications jamming amplifier to demonstrate their potential for future jammer applications. A prototype very high frequency communications jamming system will be developed for Remotely Piloted Vehicles.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Continuing	Not Applicable
ROUTE							

FY 1979 and 1980 decreases of <sup>are</sup> ~~for~~ due to more accurate estimation as FY 1979 begins.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.15.A

Sub Mission Area: #122 - Electronic Warfare Technology

Title: Tactical Electronic Warfare Technology

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is the exploratory development of tactical electronic warfare (EW), to include electronic countermeasures (ECM) and electronic counter-countermeasures (ECCM), techniques, components and equipments to be targeted against enemy communications and non-communications systems (including electro-optics and infrared communications and non-communications) associated with hostile weapon systems and units. New and improved methods and techniques will be developed to provide for improving and ECM/ECCM control by increasing operational effectiveness while reducing size and weight and increasing reliability. This program is also based on the need for continuous improvement of existing techniques and the development of new techniques for dealing with advances in state-of-the-art. As methods of communications/electronics become more sophisticated, equipment must also become more sophisticated if we are to adequately counter new threats. Technology development is also required to minimize the total cost of development, acquisition and operation of electronic warfare equipment.

The vulnerability of the techniques and methods

considered.

will also be

G. RELATED ACTIVITIES: This work is in direct support of the Program Manager for Aircraft Survivability Equipment and program elements: 6.37.45.A/D905 (Tactical Electronic Support Measures (ESM) Systems), 6.37.45.A/D925 (Tactical EW and Intelligence Command and Control Systems), 6.37.55.A/D251 (Protective EW Equipments), 6.37.55.A/DK12 (Division ECM Systems), 6.37.55.A/DK13 (Corps Tactical ECM Systems), 6.47.45.A/D906 (Tactical ESM Systems), 6.47.45.A/D926 (Tactical EW and Intelligence Command and Control Systems), 6.47.50.A/DL12 (Division Tactical ECM Systems), and 6.47.50.A/DL13 (Corps Tactical ECM Systems). Tri-Service technical efforts in EW receive extensive review as a result of participating in Joint-Service Technical Programs ECCM Workshops and Joint Technical Coordinating Groups which reduce duplication among the Services. Coordination is also furthered through tri-Service preparation of a Technology Coordinating Paper on Electronics and the annual Under Secretary of Defense for Research and Engineering (USDRE) reviews. Numerous specific subtasks are conducted on an inter-service basis including work on radar jamming, optical and electro-optical countermeasures, missile threat detection, laser jamming sources and optical augmentation.

H. WORK PERFORMED BY: The US Army Electronics Research and Development Command (ERADCOM), Adelphi, MD; Electronic Warfare Laboratory (EWL), Fort Monmouth, NJ; US Army Signals Warfare Laboratory (SWL), Warrenton, VA; and White Sands Missile Range (WSMR), NM. Supporting efforts are provided by the US Army Armament Research and Development Command, Picatinney Arsenal, NJ; Letterman Research Institute, San Francisco, CA; Naval Weapons Center, China Lake, CA; Georgia Institute of Technology, Atlanta, GA; Pacific Missile Test Center, Point Mugu, CA; Air Force Avionics Laboratory, Wright Patterson Air Force Base, OH. Contractors include: Hughes Aircraft Company, Culver City, CA; Stanford Research Institute, Huntsville, AL; GTE Sylvania, Mountain View, CA; RCA Corporation, Princeton, NJ; Honeywell, Incorporated, Lexington, MA; Rockwell International, Anaheim, CA; Quest Research Corporation, McLean, VA; ITEK Corporation, Lexington, MA; Bunker Ramo Corporation, West Lake Village, CA; Sanders Assoc., Nashua, NH and Hazeltine Corp. Greenlawn, NY.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:



Program Element: #6.27.15.A

DoD Mission Area: #122 - Electronic Warfare Technology

Title: Tactical Electronic Warfare Technology

Budget Activity: #1 - Technology Base

1. FY 1978 and Prior Accomplishments: Potential countermeasures (CM) techniques were tested and results evaluated. Initiated development of the Smith Modulator for all three services. Improved AN/ALQ-144 Infrared (IR) source. Initiated development of a modular adaptive signal sorter (MASS) to provide a flexible capability against electronic warfare (EW) to developed in support of tri-service missile detector development. Simulation and flare investigation for a variety of missiles CM was initiated. CM against laser targeting devices were initiated. Simulation/investigation to define effectiveness was initiated. Designed and tested steerable antenna null processing. Improved waveform for fast frequency hopping (FFH) signals. Performed analysis of exhaust plume radiation and selected promising jamming concepts. Investigated biodegradable chaff to solve environmental contamination problem. Investigated of ground based surveillance radars. A high power broad bandwidth communications jammer amplifier utilizing electron-bombarded semiconductor (EBS) active device was designed. Development of a multichannel communications sensor for drone aircraft as part of a and a contract awarded for a limited frequency model of the system. Investigated a very high frequency (VHF) high gain communications jamming antenna for use on BLACKHAWK helicopter.

A continuous wave

was tested to define

#### Limitations of

2. FY 1979 Program: Effort will continue to develop techniques will be evaluated. Continue efforts on signal processing and surface acoustic wave/charge coupled device (SAW/CCD) digitizer. Integrate test results, concept developments and latest intelligence findings into air defense EW design program. Demonstrate microwave pulse storage techniques. Initiate CM against Smith Modulator for incorporation into production hardware. Continue improvements for missile detector program. Continue effort on CM against laser/night vision devices. Continue optical target discrimination and optical signature measurement efforts. Initiate efforts on CM against EO devices. Complete development of steerable null technology. Continue development of high resolution capability. Start feasibility effort on plume modulation and begin development of high resolution capability. Initiate generic chaff program. Initiate measurements and handling/packaging techniques for missiles. Measurements will be made of the signatures of ground-to-air and ground-to-ground missiles. Effort will continue to develop CM against optical trackers. Field tests will be conducted to verify that signature polarization is unique to a given missile. Improved power combiner, power supplies and develop a cooling system for a field testable ruggedized missile. Continue development of a multichannel sensing system for use on a drone and development of an for the Drone guidance system being developed. Complete VHF communications jamming antenna investigation for the BLACKHAWK helicopter. Initiate investigation

Program Element: #6.27.15.A

DoD Mission Area: #122 - Electronic Warfare Technology

Title: Tactical Electronic Warfare Technology

Budget Activity: #1 - Technology Base

of threat radars to determine most effective jamming signals modulation(s). Configure a spread spectrum receiver to detect, acquire and determine a

3. FY 1980 Planned Program: Brass board of adaptive signal processor will be developed for recognizing frequency hopping, pulse stagger and multi-pulse emitters. The surface acoustic wave/charge coupled device (SAW/CCD) digitizer work will continue. Radar targeting effort will continue with the development of experimental equipment will be acquired. Countermeasures (CM) against receiver work will continue. Missile detector tech- work will

brass board repeater components. In the assembled and a demonstration test initiated, including directive antenna techniques, will continue.

niques using multiple discriminants will be investigated. continue. Optical CM effort will be expanded to include

Optical target discrimination and signature measurements will continue. Development of a simple 10.6 micron laser warning receiver and a continuous wave/pulse doppler warning receiver subsystem will continue. Steerable null development will be com- pleted. Methods of defeating hostile emitter location systems will be investigated. Effort on plume modulation will continue.

Work on the Generic Chaff programs will continue. Test a high power communications jamming amplifier to evaluate the suitability. Complete the Drone multi-channel sensing system and test, effort will transition to program 6.37.55.A (Homing Anti-Radiation Drone Sensing System).

The very high frequency (VHF) communications jamming antenna for BLACK HAWK will be completed and testing initiated. Selected radar jamming modulations will be tested against specific radars. Experimental receiving system will be used for monitoring and a limited amount of in-house laboratory experimentation and modeling. Approximately three personnel at US Army Signals Warfare Laboratory and ten personnel at US Army Electronics Warfare Laboratory are involved with program management, contract

4. FY 1981 Planned Program: Continue technology efforts in the areas of increasing targeting accuracy at communications frequencies, adaptive signal sorting and processing, CM against

advanced missile detectors,

CM, plume

modulation technology, Generic Chaff

A jamming module containing a

technique will be flight tested. Continued investigations for improved communications jamming antennas. Radar modulation analysis effort will continue. Brassboard limited frequency model of the high power radar jamming antennas for laboratory evaluation.

Initiate a program to determine the best electronic CM against digital data links. Initiate development techniques/hardware to exploit An electro-optical data base will be developed. Investigate

techniques for a single station radar location system.

5. Program to Completion: This is a continuing program. As hostile electronic warfare equipments become more sophisticated, friendly equipments must also become more sophisticated if they are to remain viable in any future conflict.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #A042

Program Element: #6.27.15.A

DoD Mission Area: #122 - Electronic Warfare Technology

Title: Electronic Warfare Technology

Title: Tactical Electronic Warfare Technology

Budget Activity: #1 - Technology Base

A. DETAILED BACKGROUND AND DESCRIPTION: The

deny friendly forces the use of the electromagnetic spectrum. The objective of this program is to improve the Army's tactical EW capability to: (1) target and countermeasure command and control, radars, data links, and other hostile radio-electronics by means of new, adaptive, and expendable EW techniques; (2) protect friendly combat forces and equipment by EW defeating hostile threat weapon systems; (3) protect friendly communications-electronic systems from hostile EW interference with electronic countermeasures (ECM) hardening; for noncommunications EW the approach is to develop a new generation of compatible, modular and expendable equipment to be deployed in high risk areas. For communications targeting, pursue methods to accomplish multipath compensation. For the protection of combat systems, the general approach is to provide warning, jamming and/or decoying of the weapon system and/or weapon operator. A family of warning receivers will be developed which are capable of warning against radars and missiles equipped with ECCM features, will be developed which will deploy rapidly and better match the characteristics of the protected target, thereby defeating decoy cancellation schemes. In the vulnerability/ECCM area the approach includes development of ECM technologies for communications, development of ECM technologies for combat surveillance systems, and development of EW threat technologies for use in EW missile vulnerability programs. In carrying out this program methods and techniques for reducing size and weight as well as increasing reliability will be developed. Continuous improvement and advancement is needed in tactical self protection electronic warfare techniques to stay abreast of and in the state-of-the-art in all areas needed to achieve success on the battlefield. Advances in technology are also needed to reduce/minimize the total cost of development, acquisition and operation of electronic warfare systems.

US developments.

To accomplish effective jamming against

will be developed.

as well as electronic warfare (EW) systems to

will also be evaluated.

B. RELATED ACTIVITIES: This work is in direct support of the Program Manager for Aircraft Survivability Equipment and program elements: 6.37.45.A/D905 (Tactical Electronic Support Measures (ESM)), 6.37.45.A/D925 (Tactical Electronic Warfare and Intelligence Command and Control Systems), 6.37.55.A/D251 (Protective Electronic Warfare (EW) Equipment), 6.37.18.A/D626 (Non Missile Vulnerability/Susceptibility), 6.37.18.A/D267 (Missile Vulnerability/Susceptibility), 6.36.55.A/DK12 (Division Tactical Electronic Countermeasures (ECM) Systems), 6.37.55.A/DK13 (Corps Tactical ECM Systems), 6.47.45.A/D906 (Tactical ESM Systems), 6.47.45.A/D926 (Tactical EW and Intelligence Command and Control Systems), 6.47.50.A/DL12 (Division Tactical ECM Systems), and 6.47.50.A/DL13



Project: #A042

Program Element: #6.27.15.A

DoD Mission Area: #122 - Electronic Warfare Technology

Title: Electronic Warfare Technology

Title: Tactical Electronic Warfare Technology

Budget Activity: #1 - Technology Base

(Corps Tactical Electronic Countermeasures (ECM) Systems). Tri-Service technical efforts in electronic warfare receive extensive review as a result of participating in Joint-Service Technical Programs, Electronic Counter-Countermeasure Workshops and Joint Technical Coordinating Groups which reduce duplication among the Services. Coordination is also furthered through Tri-Service preparation of a Technology Coordinating Paper on Electronics and the annual Under Secretary of Defense for Research and Engineering (USDRE) review. Numerous specific subtasks are conducted on an inter-service basis including work on

These

subtasks take the form of joint funding/coordination with other Services.

C. WORK PERFORMED BY: The Electronic Warfare Laboratory, US Army Electronics Research and Development Command, Fort Monmouth, NJ, is the in-house developing organization responsible for this project. Contractors providing support to this program include: Sanders Assoc., Nashua, NH; Honeywell Inc., Lexington, Mass; Hazeltine Corp., Greenlawn, NY; RCA Corp., Camden, NJ; and SRI International, Menlo Park, CA. There are approximately twenty additional contractors supporting this program; the total dollar value of these additional contracts is approximately \$1,000,000.

#### D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Potential countermeasures techniques against were tested and results evaluated. A program was initiated to develop the Smith Modular for all three Services. The feasibility of a assessment/selection of promising was established. Continued program for this purpose. Initiated development of a modular adaptive signal sorter (MASS) to provide a flexible capability against for achieving targeting accuracy against ground radio location. These techniques will be tested using obtained from a special signal collection apparatus developed for this purpose. Initiated program for radar targeting using remote expendable sensors. Continued effort on air defense electronic warfare (EW) techniques to effectiveness.

were continued and an improved developed in support of tri-service missile detector developments. Simulation and flare investigation for a variety of missile countermeasures was initiated. Countermeasures against laser targeting devices was initiated. Simulation/investigation to define effectiveness was initiated. Designed and tested processing. Improved waveform for fast frequency hopping (FFH) signals. Performed analysis of exhaust plume radiation and selected promising jamming concepts. Investigated biodegradable chaff to solve environmental contamination problem. Investigated of ground based surveillance radars.

Project: #A042

Program Element: #6.27.15.A

DoD Mission Area: #122 - Electronic Warfare Technology

Title: Electronic Warfare Technology

Title: Tactical Electronic Warfare Technology

Budget Activity: #1 - Technology Base

2. FY 1979 Program: Effort will continue to develop techniques to feature. The Smith Modulator data and development of

antennas to improve

wave/charge coupled device (SAW/CDD) digitizer. Integrate test results, concept developments and latest design program. Demonstrate microwave pulse storage techniques. Initiate countermeasures

against monopulse trackers. Develop

hardware. Continue measurements and filter detector improvements for

effort on countermeasures against laser/night observation devices. Continue optical target discrimination and optical signature

measurement efforts. Initiate efforts on countermeasures against

antenna technology. Start feasibility effort on plume modulation and begin development of high resolution

Initiate generic chaff program. Start design of measurements and handling/packaging techniques for

Prototype a

Measurements will be made of the signatures of ground-to-air and ground-to-ground missiles. Continue to develop techniques to detect on-coming missiles. Countermeasures against given missile. Field tests will be conducted to verify that signature polarization is unique for a

3. FY 1980 Planned Program: Brassboard of adaptive signal processor will be developed for recognizing frequency hopping, pulse-staggered, and multi-pulse emitters. The Surface Acoustic Wave/Charge Coupled Device (SAW/CDD) digitizer work will continue.

development of brassboard repeater components. In the

acquired, assembled and a demonstration test initiated, including directive antenna techniques. Countermeasures against experimental equipment will be

techniques using multiple discriminants will be investigated.

continue. Optical countermeasures (OCM) effort will be expanded to include

Optical target

laser warning receiver and a continuous wave/pulse doppler warning receiver subsystem will continue. Development of a simple 10.6 micron

development will be completed. Methods of defeating

modulation will continue. Work on

programs will continue. Approximately ten personnel at the Electronics Warfare Laboratory are involved with program management,

contract monitoring and a limited amount of in-house laboratory experimentation and modeling.

Project: #A042  
 Program Element: #6.27.15.A  
 DoB Mission Area: #122 - Electronic Warfare Technology  
 Title: Electronic Warfare Technology  
 Title: Tactical Electronic Warfare Technology  
 Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: Continue technology efforts in the areas of increasing targeting accuracy at communications frequencies, adaptive signal sorting and processing, air defense electronic warfare, countermeasures against

a  
 brassboard high resolution  
 will be flight tested.  
 A jamming module containing trackers. A

5. Program to Completion: This is a continuing program. As communications, electronics, infrared and electro-optical systems become more sophisticated, the Army's electronic warfare equipments/systems must keep pace in order to effectively counter new threats. Conversely as new and advanced EW techniques and systems evolve, better electronic counter-countermeasures techniques must be developed if the Army's weapons systems are to maintain their operational effectiveness in a future electronic warfare environment.

6. Major Milestones: Not Applicable.

7. Resources (\$ in thousands)

	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Cost	
NOTE							
Funds (current requirements)							Not Applicable
Funds (as shown in FY 1979 submission)							Not Applicable

FY 1978 Increase is Internal reprogramming to increase emphasis for development of a  
 FY 1980 decrease due to budgetary constraints which preclude funding at desired level.



# FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.16.A

Title: Human Factors Engineering in Systems Development

DoD Mission Area: #132 - Training and Personnel Technology

Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total	
								Estimated Costs	Not Applicable
AM 70	Human Factors Engineering in Systems Development		4000	5922	6771	7247	Continuing		Not Applicable

## B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:

1. User Problem: Improve US Army artillery system effectiveness in combat; increase US Army's ability to fight in built-up areas in Europe; improve individual soldier's personal equipment and its compatibility with all other items (weapons, gas mask, load carrying equipment, and armored vest); reduce noise damage to hearing among military personnel; improve performance of individual and crew-served weapon systems during periods of reduced visibility and smoke on the battlefield; improve development of visual displays for future Army air defense systems; reduce aircrew workload imposed by the introduction of new electronic displays, controls and data processing equipment into Army helicopters; improve ammunition resupply procedures.

2. Objective: Research must be conducted to furnish soldier-machine interface data to US Army Materiel Development and Readiness Command (DARCOM) Project and Product Managers in order to integrate that data into the design of the weapon system as early as possible to assure full weapon system effectiveness in the field.

3. Products: This project guides the design, development, test and evaluation of Army materiel to make best use of soldier capabilities and avoid human limitations. Specific systems development benefiting from this program include: XM-1 Tank turret development, Black Hawk Helicopter equipment display, Artillery Battery Computer System, COPPERHEAD/155-mm Howitzer equipment employment, XM198 Self-Propelled Howitzer equipment employment, and artillery radar displays.

4. How used: Guidelines and procedures furnished DARCOM Project and Product Managers have guided the development of (1) a battery level computer for the Artillery Fire Direction Center, (2) the TOW Antitank Weapon System, (3) new infantry body armor and helmets, (4) one-handed flight control for helicopters, (5) fire control equipment for tanks, (6) ADP systems for conventional artillery, (7) mounting of anti-tank weapon systems on armored personnel vehicles, and (8) protection for ammunition handlers in combat loading the tank while under hostile fire. This program also directly impacts the development, design, test and evaluation of many other Army weapon systems.

Program Element: #6.27.16.A Title: Human Factors Engineering in Systems Development  
 DoD Mission Area: #132 - Training and Personnel Technology Budget Activity: #1 - Technology Base

C. BASIS FOR FY 1980 RDTE REQUEST: Research will identify man-equipment shortcomings during Military Operations in Built-up Areas (MOBA). Field evaluation and testing of the effectiveness of equipment changes for operations in the MOBA environment will be accelerated. Other work will improve procedures to increase the accuracy and timeliness of artillery fire; reduce armored vehicle internal noise and thereby reduce hearing damage to the crew; seek means to improve soldier and crew performance in low visibility, smoke environments. This program will also attack problems of how to reduce soldier maintenance time; how to improve air defense weapon system effectiveness by accelerating the human decision making process; how to improve soldier/equipment performance in hitting moving targets and how to improve the Army's ammunition resupply system.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE	FY 1978	FY 1979	FY 1980	Additional to Completion	Total	
					Estimated Cost	Not Applicable
Funds (as shown in FY 1979 submission)	3950	5922	7271	Continuing		
The change in FY 1978 provided additional human factors evaluation during an Army field test to improve conventional artillery equipment and fire direction procedures, forward observer procedures and fire control. The change in FY 80 will curtail identification and solution of problems of Military Operations in Built-up Areas.						

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.16.A  
DoD Mission Area: #132 - Training and Personnel Technology

Title: Human Factors Engineering in Systems Development  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The U.S. Army Human Engineering Laboratory (HEL), Aberdeen Proving Ground, Md., is a unique, central laboratory of the U.S. Army Materiel and Readiness Command (DARCOM), that provides R&D support to all of the DARCOM commodity commands and Project Managers in the technology area, Human Factors Engineering. The Laboratory, composed of 210 military and civilian personnel, conducts fundamental and applied research, weapon system concept feasibility evaluations; system performance measurements; and provides human factors engineering application support on all materiel items in various stages of development. The Laboratory operates a DOD-wide scientific data bank which includes data collected anywhere in the world in this technology field, including over 1000 reports published by the Laboratory in the last 27 years. Thus, the Laboratory, through research and field experiments, supports the development of small arms, infantry weapons, aviation, artillery, missile systems, communication and electronics equipment, combat vehicles, wheeled vehicles, clothing and personal equipment. The ultimate objective of this work is to assist in the development and production of the best and least expensive weapons and equipment for our soldiers for combat anywhere in the world. There are human factors engineering detachments or offices at major Army development activities, including the Project Manager for Training Devices (PM TRADES).

G. RELATED ACTIVITIES: This Laboratory (HEL) is a leader in tri-service coordination, e.g., under a tri-service human factors technology coordination group. HEL chairs or participates in a helicopter human factors engineering sub-committee and a human factors test and evaluation sub-committee; assembles all appropriate data and publishes all tri-service human factors engineering design standards and Human Factors Engineering Design Handbooks; chairs two NATO R&D committees and performs an independent human factors engineering review for all major Army materiel systems. Biomedical input into Army materiel design is coordinated through this Laboratory.

H. WORK PERFORMED BY: In-house work is performed by the U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, Md., supported by USA Tank-Automotive R&D Command (TARADCOM); USA Missile R&D Command (MIRADCOM); and Communication R&D Command (CORADCOM), and USA Armament R&D Command (ARADCOM). Contractors with contracts exceeding \$25,000. are: AMI Corporation, Cockeysville, Md.; Georgia Tech Research Institute, Atlanta, Ga.; Emerson Electric, St. Louis, Mo.; Food Machinery Corporation, San Jose, Calif.; BMR, Inc., Sarasota, Fla.; General Motors Corp., San Jose, Calif.; Abbott Associates, Alexandria, Va.; Mathematical Applications Group, Inc., Elms Ford, N.Y. There is one other contract totalling \$7,200.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Past research has identified difficulties of communication during combat in built-up areas, and developed procedures for minimizing those problems. The Human Engineering Laboratory (HEL) serves as the lead Army agency in this area. Developed and successfully demonstrated a one-handed flight control for helicopters. Designed a test and completed the analysis to include publishing the results of a major test to determine the optimum concept of integrated employment of future artillery weapon systems. Results will guide development of improved artillery materiel and its more effective employment in combat. In close coordination with US Army Natick Research and Development Center, successfully developed the new Infantry Kevlar helmet and body armor system which was type classified in FY 78. The successful work of the US Army Human Engineering Laboratory (HEL) has earned it the "Army R&D Award for Excellence" for the past 4 years.



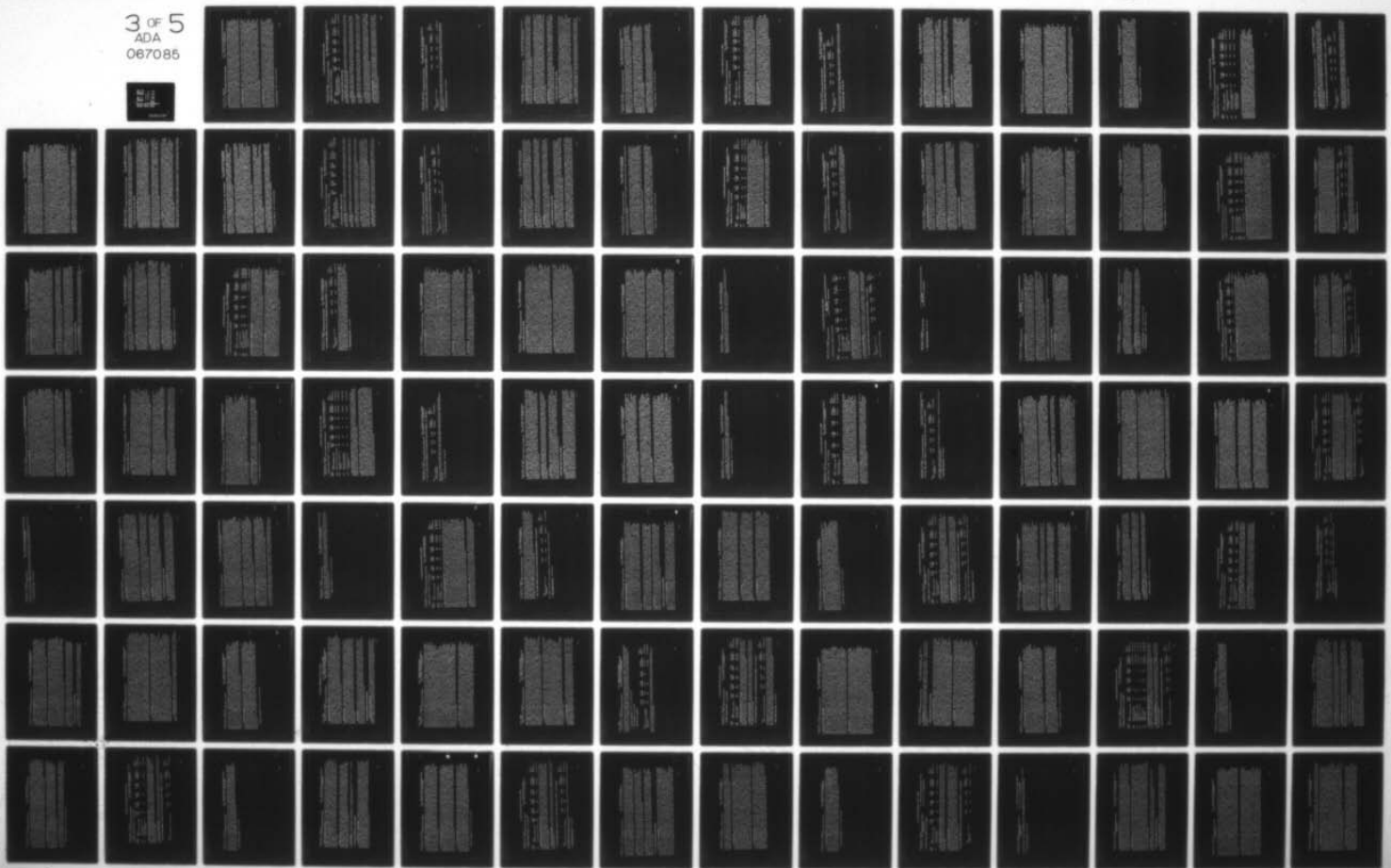
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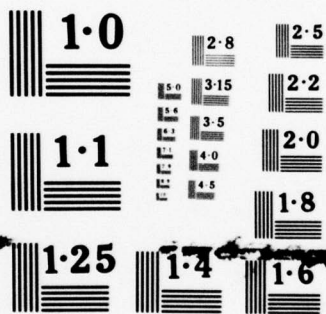
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MICROCOPY RESOLUTION TEST CHART

Program Element: #6.27.16.A

Title: Human Factors Engineering in Systems Development

DoD Mission Area: #132 - Training and Personnel Technology

Budget Activity: #1 - Technology Base

2. FY 1979 Program: Complete research and development in conjunction with Armament Research and Development Command on the new XM29 gas mask and associated individual protective clothing and equipment. Initiate research on new individual weapon position station for track vehicles. This task is being conducted in coordination with Tank-Automotive Research and Development Command. Complete the test design and development of the integrated field artillery system test in support of combat and materiel development of future artillery weapons. Primary emphasis will be placed on automatic data processing equipment employment. Results to be published in 4th Qtr FY 79. Determine the effects of smoke on performance of tankers and infantry in a battlefield environment. Findings will guide hardware development or modification as well as concept development of tactics, doctrine and related countermeasures. Conduct and complete field test on high rates of ammunition resupply. This will be accomplished in conjunction with other operational Army units in order to assure that future ammunition resupply can realistically sustain anticipated firing rates.
3. FY 1980 Planned Program: Conduct research towards a more effective individual weapon position station in track vehicles and a small arms weapon system to be used for shooting from a combat infantry vehicle firing port. Field test the integration of field artillery weapons and equipment to include developmental ground laser designators, digital data transmission devices, automatic data processing equipment for fire direction centers, and remotely piloted vehicles with associated ground support equipment. Develop and test improved load-carrying equipment for the individual soldier which will accommodate the latest equipment and not interfere with soldier performance. This task is coordinated with and in support of the Army's Clothing and Equipment Laboratory at Natick, Mass. Initiate research to determine man-machine interface problems associated with developmental infantry weapon systems and determine human performance limitations associated with the squad automatic weapon. Evaluate powered tracking versus hand tracking systems to obtain data on optimizing precise aiming performance. Redesign infantry anti-tank target tracking systems on basis of research findings. Develop a helicopter man/machine data base for simplifying aircrew operations and maintenance tasks, simplify primary flight controls, cockpit controls and displays. This is a coordinated tri-Service effort. Evaluate effects of dust, fog, darkness and smoke on battlefield visibility and associated individual performance degradation. Conduct research on how to improve command, control, and communications in village and city fighting. There are 86 professional and 35 support personnel involved in this program.
4. FY 1981 Planned Program: Conduct research needed to guide development of more effective, lightweight weapon systems, and communication equipment for effective fighting in villages and built-up areas such as Europe. Perform human factors engineering research needed to improve effective one-handed flight control system for flying helicopters. System will use electrical servo mechanisms. Assist the Armament Research and Development Command in applying artillery test results in the development of more effective automated system for artillery weapons. Based on research in FY 79 and FY 80, changes will be proposed to current materiel handling equipment in order to more effectively handle ammunition in high rates of fire situations. Conduct research, development, test and evaluation in order to implement new procedures and methods for ordering spare parts for major end items in order to significantly reduce the present high human error rates while increasing operational availability of combat equipment. This research supports a priority requirement from the Army's Deputy Chief of Staff for Logistics and field Army logistic commands.
5. Program to Completion: This is a continuing program.



FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.17.A

Title: Human Performance Effectiveness and Simulation

DoD Mission Area: #132 - Training and Personnel Technology

Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Continuing	Total Estimated Costs
A790	TOTAL FOR PROGRAM ELEMENT	3000	3080	3733	4497		Not Applicable
	Technology for Improved Soldier Effectiveness in Systems	3000	3080	3733	4497	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:

1. User Problem: Range of present day weapons, operational costs and safety considerations force reliance on simulation for individual and unit training to attain and sustain combat readiness. Achieving design capabilities of weapon systems in the field requires highly proficient individuals and crews.

2. Objectives: Devise simulation and other methods to assure individual and unit proficiency without recourse to extensive maneuver and training areas. Provide crew procedures, job aids, and job engineering to assure that Army weapon systems are operated and maintained at peak design capability. Improve measures for assessing individual and unit readiness and diagnosing skill deficiencies.

3. Products: Guidelines for design of training devices and simulators. Programs of instruction for effective use of training devices and simulators. Instructional technology for: the self-contained training program for the Army's Tactical Fire Direction System (TACFIRE); the Multiple Integrated Laser Engagement System; and for refresher training on operator and maintenance skills within units.

4. How Used: This effort furnished prototype training programs for the Army's UH-1 helicopter flight training simulator. Results also supported the training effectiveness evaluation of the DRAGON anti-tank missile launch effects simulator. Results are also used by the Project Manager for Training Devices (PM TRADE) in developing training devices and by US Army Training and Doctrine Command (TRADOC) in preparing individual and unit instructional programs and performance assessment procedures. Engagement simulation training for combat units is also based on this research.

C. NASIS FOR FY 1980 RDTE REQUEST: Research will include development of simulator instructional techniques for helicopters and tank crew training; investigation of transfer of training techniques to ascertain the points of diminishing returns from substitution of simulator training for actual system training; development of simulator training for maintenance of electronic and automatic data processing equipment; and determination of aircraft instrument displays and location in the cockpit to enable the pilot to maintain proper aircraft orientation.

Program Element: #6.27.17.A Title: Human Performance Effectiveness and Simulation  
 DoD Mission Area: #132 - Training and Personnel Technology Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL BUDGET REQUESTS: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
NOTE Funds (as shown in FY 1979 submission)	4392	4696	4696	Continuing	Not Applicable

The differences in the funding profiles between the FY 1980 and FY 1979 Congressional Descriptive Summaries reflect Congressional reductions in FY 1979 and restructuring of the Army personnel and training EDTE program in compliance with Housed Armed Services Committee guidance.

E. OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.27.17.A

DoD Mission Area: #132 - Training and Personnel Technology

Title: Human Performance Effectiveness and Simulation

Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** This program provides technology to develop or improve: (1) aids for designing and producing simulator instructional techniques for helicopter, tank, artillery and air defense systems; (2) simulator instructional techniques for team training; (3) simulator training for equipment maintenance; (4) tactical symbols and graphics representation for use in decision analysis and evaluation of combat information obtained from automated data processing systems; (5) work procedures and task analysis for improved individual and team operations.

**G. RELATED ACTIVITIES:** This research is coordinated with the Navy's 6.27.57.N, Training and Human Engineering Technology and with the Air Force's 6.22.05.F, Training and Simulation Technology through DoD topical reviews, Training and Personnel Technology Conferences, annual budget and apportionment reviews, tri-service Technology Coordinating Panels, and participation on tri-service groups, such as the Joint Services Helicopter Human Resources Research Coordinating Panel. Through such means, as well as direct contact, coordination is also effected with specific service laboratories and elements, including Air Force Human Resources Laboratory (AFHRL), Naval Personnel Research and Development Center (NPRDC), Project Manager for Training Devices (PM TRADE), Air Mobility Research and Development Laboratory (AMRDL), Army Human Engineering Laboratory (HREL), and Naval Training Equipment Center (NTEC), to cover research in visual displays, training simulation, human factors in operational testing, aviation crew performance, and instructional technology.

**H. WORK PERFORMED BY:** Contractors include: Anacapa Sciences, Inc., Santa Barbara, CA; Bolt, Beranek & Newman, Cambridge, MA; Human Resources Research Organization, Alexandria, VA; Human Systems, Inc., Memphis, TN; Perceptronics, Woodland Hills, CA. In-house work is performed by the US Army Research Institute for the Behavioral and Social Sciences and its field units distributed at major installations, including Ft Benning, GA; Ft Bliss, TX; Ft Hood, TX; Ft Knox, KY; Ft Leavenworth, KS; Ft Ord, CA; Ft Rucker, AL; Ft Sill, OK; Ft Benjamin Harrison, IN; and Germany.

#### 1. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. **FY 1978 and Prior Accomplishments:** Guidelines were developed for tri-service procedures for Instructional Systems Development (ISD). Test was completed for computerized training in troubleshooting. High mobility/agility driver research was completed. A dynamic model and data base were developed to create computer-generated images for flight instruction. A data access language was designed for advanced intelligence automated data processing systems. The impact of organizational variables on simulated tactical performance of battalions was completed. Effectiveness of light-attenuating goggles for simulating night training during the daytime was demonstrated. A framework of tactical symbology was developed for more effective portrayal of the battlefield. In-house facility involved was the US Army Research Institute for the Behavioral and Social Sciences. Contractors involved were Applied Science Associates, Inc., Valencia, PA; General Electric Co., Daytona Beach, FL; Bolt, Beranek & Newman, Inc., Cambridge, MA; Human Resources Research Organization, Alexandria, VA; Human Systems, Inc., Memphis, TN; Vector Research, Inc., Ann Arbor, MI; Perceptronics, Woodland Hills, CA.

2. **FY 1979 Program:** (a) Develop job aids for use with tri-service procedures for Instructional System Development; (b) develop two-sided tactical training games; (c) develop computerized training techniques for maintenance troubleshooting; (d) develop requirements for the visual display in a simulator for training rotary-wing pilots; (e) develop simulator instructional



Program Element: #6.27.17.A

Title: Human Performance Effectiveness and Simulation

DoD Mission Area: #132 - Training and Personnel Technology

Budget Activity: #1 - Technology Base

techniques for retaining pilot skills in operational Army aviation units; (f) develop a prototype Army Training and Evaluation Program (ARTEP) for tactical automated data processing system teams; (g) develop embedded instructional technology, where the operational system itself has a built-in instructional program, e.g., TACFIRE; (h) develop a model of organizational factors in command and control to assess impact of doctrinal changes on small unit training for the Tactical Operations Center; (i) develop visual displays and simulator instructional technology to improve human performance in air defense systems.

3. FY 1980 Planned Program: (a) Develop instructional materials to guide TRADOC schools in preparing simulator training programs. (b) Prepare prototype training programs and support training effectiveness evaluation for the Combined Arms Tactical Training System (CATTS) simulator. (c) Conduct research on individual competitive training exercises (training games) which motivate the soldier and facilitate the learning of combat and technical skills. (d) Extend computerized training to electronic equipment maintenance. (e) Develop computer programmable visual displays to assist the decision maker in evaluating tactical information. (f) Apply simulator technology and advanced visual display techniques to provide decreased operator effectiveness in air defense systems. (g) Support development of the armor full crew interaction simulator. A total of 45 professional and 25 support personnel are involved in this effort.

4. FY 1981 Planned Program: (a) Complete work related to Instructional System Development; (b) develop model for analyzing individual performance for automated systems, to crew performance for automated systems; (c) establish a human factors concept for automated data processing in continuous tactical operations; (d) conduct research on combat information-processing and decision-making in a division-level tactical environment, including the use of visual display and simulator technology; (e) evaluate display and symbology related to airborne tactical information automated data processing systems.

5. Program to Completion: This is a continuing program.

# FY 1980 ROTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.19.A

Title: Mobility & Weapons Effects Technology

DoD Mission Area: #153 - Military Engineering Technology Base

Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>3855</b>	<b>4915</b>	<b>5150</b>	<b>5269</b>		<b>Not Applicable</b>
AT40	Mobility and Weapons Effects Technology	3855	4915	5150	5269	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** Fighting a numerically superior, modern mechanized opponent in a European environment requires maximum exploratory development in military engineering for the effective employment and survivability of the Army's sophisticated weapons systems through: (1) ground mobility/countermobility technology that exploits the best killing characteristics of our new weapons and insures that battlefield terrain is used effectively as a force multiplier; (2) techniques for rapid repair of battle damaged facilities and construction in support of combat and logistical elements in the theater of operations; (3) a knowledge of weapons effects and the response of protective structures to nuclear and conventional munitions for increased battlefield survivability and more effective targeting techniques; (4) techniques for passive counter surveillance as a cost effective technology for increasing the survivability of fixed installations supporting combat operations.

**C. BASIS FOR FY 1980 ROTE REQUEST:** Improved criteria for predicting the effects of nuclear and conventional weapons will be developed to provide maneuver forces increased strike options during combat operations. Methods and criteria for using bulk and conventional explosives as a non-nuclear option in barrier and denial operations will be developed. A computerized weapons effects information and analysis system will be made available to the Department of Defense and other users. Weapons protection criteria and techniques will be developed for the field Army's repair parts computer system housed in mobile vans, for underground hardened facilities supporting critical Command, Control and Communications functions, and for troops and equipment engaged in urban warfare. Methods will be perfected to predict single vehicle performance in partially frozen ground and combat vehicle movement rates through urban areas in support of high mobility combat vehicle development, and as input to intelligence preparation of the battlefield. Methods for predicting the impact of hydrological data in the field and its effect on combat operations will be developed and a computer code to analyze installation passive counter surveillance needs will be made operational.

Program Element: #6.27.19.A  
DoD Mission Area: #153 - Military Engineering Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES (\$ in thousands):

	FY 1978	FY 1979	FY 1980	Total	
				Additional to Completion	Estimated Cost
RDTE Funds (as shown in FY 1979 submission)	3855	4915	5286	Continuing	Not Applicable

The decrease of \$136K in FY 80 results from funding requirements of higher priority Department of the Army projects. This change reduced research efforts in new concepts for hardened command facilities and line of communication surface preparation guidelines.

E. OTHER APPROPRIATION FUNDS: Not Applicable



Program Element: #6.27.19.A

DoD Mission Area: #153 - Military Engineering Technology Base

Title: Mobility & Weapons Effects Technology  
Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** Research is conducted in the areas of weapons effects, combat engineering, base development in the theater of operations, military hydrology, and construction technology for military facilities. Specific objectives are: to provide the Army a capability to predict the effects and response of military targets to nuclear and non-nuclear munitions; to develop design and operational criteria for field fortifications, and design criteria and construction techniques for underground hardened facilities; to develop, improve, and apply engineering technology for military road and airfield systems, lines of communication and base facilities, and logistics over the shore operations; to develop ground mobility techniques that assure terrain is used to maximum advantage; and to develop techniques and criteria for determining the physical properties and response of earth materials important to combat engineering and military construction activities supporting combat operations.

**G. RELATED ACTIVITIES:** Program Element 6.11.02.A, Project AT22, Research in Soil and Rock Mechanics. Formal coordination of related mission-oriented research by the Navy, Air Force, Defense Nuclear Agency, Department of Interior, Department of Transportation, and the Department of Energy is conducted through annual technical reviews, the Joint Services Civil Engineering Research and Development Coordinating Group and joint interagency activities. Informal coordination is conducted through frequent individual contacts.

**H. WORK PERFORMED BY:** Approximately 88 percent of the work is performed in-house. The U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, serves as the managing laboratory and is the primary performing activity. A portion of the work in the weapons effects is performed by the U.S. Army Construction Engineering Research Laboratory, Champaign, IL. Contractors are selected through Request for Proposals.

#### **I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

**1. FY 1978 and Prior Accomplishment:** Characterization of weapons effects relating to subsurface nuclear explosions and their effectiveness against surface and underground structures were formalized and documented. A computerized weapons effect information and analysis system was expanded to include additional prediction capabilities for fallout, radiation, and water shock. Prediction curves were developed for explosive breaching of earth and rockfill dams, for explosive excavation supporting mobility/counter mobility operations in various soils with shallow water tables, and for atomic demolitions munitions deployment against reinforced concrete piers. A design for using ordinary plastic pipe loaded with a blasting agent to create antitank ditches was developed. A computerized method for selecting fighting position designs, best for specific battlefield conditions, was developed and validated. The computer-aided terrain mobility analysis procedure was modified for use on the Worldwide Military Command Control System computer and for use by NATO as a reference mobility model. A "quick fix" technique was developed for providing access/egress routes for current bridging systems. Techniques for using sand-filled membranes as a field expedient for construction of bridge piers and abutments were developed and validated. Procedures were developed for using locally available low strength materials for rapid construction of lines of communication pavement facilities. A methodology for predicting rutting failure of flexible military pavements and unsurfaced roads and storage areas was developed.

Program Element: #6.27.19.A  
DoD Mission Area: #153 - Military Engineering Technology Base

Title: Mobility & Weapons Effects Technology  
Budget Activity: #1 - Technology Base

2. FY 1979 Program: Concepts for using explosives to create barriers and fighting positions in support of armor and anti-armor operations will be formulated. The weapons effects information and analysis system will be further updated and expanded. The ability of cables and conduits connecting buried hardened structures to withstand ground shock will be determined. The influence of shallow water table on explosive cratering will be established. Tests will be conducted with conventional weapons on typical European buildings and structures to develop vulnerability, demolition, and survivability criteria for use in the construction of training villages for troop training in urban warfare. The single vehicle gap crossing performance prediction model will be upgraded. A preliminary mobility-oriented terrain data base will be devised. Criteria for rapid construction of approach roads to tactical bridges through soft ground will be formulated. Estimates of battle damage to runways, based on NATO attack scenarios, will be developed. An airfield pavement joint design will be developed for input into a new overall airfield pavement analysis method. Shortfalls and techniques for passive counter surveillance of fixed installations from thermal sensors will be defined. A capability to repair and rehabilitate roads and storage areas and construct expedient surfacing systems under adverse weather conditions will be developed. A concept for predicting streamflows in theaters of operation will be formulated to improve the Army's hydrologic prediction capabilities that impact combat operations.
3. FY 1980 Planned Program: Criteria for predicting breaching of concrete dams by nuclear explosives will be formulated. Techniques for creating tank, artillery, and troop fighting positions and to assist in gap crossing operations with commercial blasting agents will be finalized. A preliminary user's manual for the computerized weapons effect information and analysis system will be prepared and distributed to users. Design criteria will be developed for shielding conduit systems in hardened facilities for electromagnetic radiation generated by nuclear blast. Methods for predicting damage to targets such as bridges and PDL tanks from low-yield nuclear surface bursts will be developed. Procedures for breaching and demolishing urban buildings and utility tunnels with engineer munitions will be developed. A durable material for training village construction will be developed to absorb impacting projectiles and bomb fragments. A method of predicting single vehicle performance in partially frozen ground will be developed for use as a submodel in the overall mobility terrain analysis procedure. A first generation computational system for converting conventional terrain data into more detailed mobility-terrain data will be finalized and released to users for field trials. A preliminary model to predict vehicle movement rates through urban areas will be developed. Cost effective techniques for fixed installation passive countersurveillance will be developed and current shortfalls identified. Concepts, construction guidelines, and recommended materials and protection methods for construction of soil strengthened structures will be finalized. Current technologies and operational procedures to update the Army's hydrologic capability will be defined and provided to field units in the form of manuals, bulletins, and training courses. An improved military pavement deterioration analysis system will be formulated. Procedures for the analysis and design of foundations constructed on expansive soils will be finalized. In-house personnel engaged in program: 67 professional; 53 support.
4. FY 1981 Planned Program: An improved computer code for assessing the hardness or vulnerability of strategic facilities will be developed. The user's manual for the computerized weapons effects information and analysis system will be finalized and distributed. Procedures for producing demolition charge cavities in rock by explosive methods will be formulated.

Program Element: #6.27.19.A  
DoD Mission Area: #153

Military Engineering Technology Base

Title: Mobility & Weapons Effects Technology  
Budget Activity: #1 - Technology Base

Criteria for the design, purchase, and use of earth-covered fiberglass ammunition storage bunkers will be formalized. Criteria for determining the survivability of troops and equipment in urban buildings used as fighting positions will be formulated. Procedures for creating obstacles and demolishing buildings in urban areas using engineer munitions will be developed. Design criteria and construction techniques for a mock village to support troop training in urban warfare will be finalized. Improved terrain/mobility submodels for predicting the linear feature and gap-crossing capabilities of ground vehicles will be developed. Procedures for enhancing beach trafficability using grids, fabrics, and membranes to confine sand will be finalized. Potential materials and procedures for rapid repair and restoration of bomb-damaged pavements will be evaluated. Improved methods for predicting rock behavior around tunnel and for supporting such openings will be formulated. Criteria for evaluating the effect of skin friction on pier performance in cohesive soils will be developed. Improved surfacing materials to withstand traffic from tracked vehicles will be developed for use at Army reservations. Design and construction criteria for recycling existing pavement materials for pavement rehabilitation will be finalized.

5. Program to Completion: This is a continuing program.



FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.20.A  
DoD Mission Area: #133 - Environmental Quality Research and Development

Title: Environmental Quality Technology  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Cost
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>7437</b>	<b>9448</b>	<b>9675</b>	<b>9411</b>		<b>Not Applicable</b>
D048	Environmental Quality Research & Development	2604	2892	3620	3150	Continuing	Not Applicable
A835	Identification & Health Effects of Military Pollutants	2660	3721	3531	3595	Continuing	Not Applicable
A896	Environmental Quality for Construction & Operation of Military Facilities	2173	2835	2524	2666	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** Statutory regulations require that the Army minimize the impact of its operations on the environment and meet specified standards by 1984. This program provides the exploratory development support to the Army's program for compliance with these regulations. The major program thrust is to provide the technology base necessary to enable the Army to meet 1984 and beyond pollution abatement requirements. The program consists of three projects: Project A835 is performed by the Army Surgeon General; this project is concerned with the development of toxicological data on Army unique pollutants for use in establishing environmental standards, criteria and guidelines. Project D048 is performed by the US Army Development & Readiness Command and is aimed at developing pollution abatement, treatment and recovery methods for Army ammunition plants, arsenals and depots. Project A896 is performed by the Chief of Engineers; this project develops pollution abatement, impact assessment and resource management methods for Army installations. The program is responsive to the Science and Technology Objectives for environmental quality contained in the Army Science & Technology Objectives Guide (STOG).

Program Element: #6.27-20.A  
DoD Mission Area: #133 - Environmental Quality Research and Development

Title: Environmental Quality Technology  
Budget Activity: #1 - Technology Base

C. BASIS FOR FY 1980 RDTE REQUEST: The funds requested for FY 1980 will permit identification of the best available technology economically achievable for munitions waste to meet 1984 guidelines as required by PL 95-200; continued development of methods for treatment and recovery/reuse of depot and Army unique industrial operations wastes; continued toxicological study of waste materials unique to Army operations, and development of management systems, assessment methods and abatement systems for the waste products of Army military installations.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
RDTE Funds (as shown in FY 1979 submission)	7477	9448	10459	Continuing	Not Applicable

The decrease of \$784K between the FY 1979 and FY 1980 budget request for FY 1980 results from the funding needs of higher priority DA programs. The decrease delays planned completion of methods of regional impact assessment and initiation of noise impact studies of new Army weapon systems. Decrease of \$40K in FY 78 actual expenditures resulted from funding needs of other DA programs; the decrease reduced the planned level of effort for development of technology for detection of monitoring of munitions plant wastes.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.20.A  
DoD Mission Area: #133 - Environmental Quality Research and Development

Title: Environmental Quality Technology  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: Program was initiated in 1973 to consolidate and better coordinate fragmented environmental quality exploratory development activities within the Army. The program is aimed at providing cost effective technology in support of the Army's need to achieve compliance with pollution abatement and environmental enhancement requirements for its industrial plant and military installation operations. The technical thrust areas of the program are: Environmental and Health Effects Research aimed at developing a data base of mammalian, aquatic and vegetative chronic and acute toxicity information on the unique chemical wastes resulting from Army munitions plants and other pollution sources; Environmental Monitoring, Management, Assessment and Planning Technology to provide effective methods, procedures and systems for measuring and identifying pollutants, assessing environmental impacts of planned actions and information data bases for effectively performing management and planning functions with appropriate consideration of environmental protection and enhancement; Source Reduction, Control and Treatment Technology to provide a technology base methods, processes and systems to enable the Army to deal effectively with the pollution problems at its industrial facilities and military installations.

G. RELATED ACTIVITIES: Projects, AH68 (Processes in Pollution Abatement Technology) and BS04 (Identification and Health Effects of Military Pollutants) in Program Element 6.11.02.A, comprise the basic research portion of the Army Environmental Quality Technology Base Program. Project AH68 is concerned with gaining an understanding of the fundamental chemical/physical processes that can occur during treatment/disposal of munitions wastes; Project BS04 is concerned with investigating the feasibility of developing less costly and time consuming methods for conducting toxicology studies. Program Element 6.27.20 provides technology transfer to the pollution abatement activities being accomplished in the Military Construction, Army (MCA) and the Operation and Maintenance, Army (OMA) appropriations. The Air Force and the Navy have environmental quality research efforts directed toward satisfying their specific mission needs. In areas of common service interest, joint efforts are undertaken or a service may adopt the results of another service's research. The services' environmental quality research activities are monitored by Department of Defense through annual budget/apportionment reviews and periodic Topical Reviews for program areas of tri-service interest. At the service staff level, semi-annual meetings of the Joint Civil Engineering Research & Development Coordination Group (JCERDCG) enables coordination of technical programs among the services. Service coordination is further enhanced through the DOD area Coordination Paper No. 42 on Environmental Quality Research and Development. This document is periodically revised through tri-service coordination. Inter-service coordination also occurs routinely at the technical level on joint programs and other programs of mutual interest. Other federal agencies which pursue environmental quality research programs related to their roles in the federal government are: The Environmental Protection Agency (EPA), Department of Health, Education and Welfare (HEW), Department of Interior (DOI), National Aeronautics and Space Administration (NASA) Department of Agriculture (DA), the Department of Energy (DOE), Department of Transportation (DOT) and the Department of Housing and Urban Development (HUD). Coordination with these agencies is undertaken at the technical level to avoid duplication. Joint programs are undertaken in areas of mutual interest.

H. WORK PERFORMED BY: Approximately 49% of the research effort is performed in-house by the U.S. Army Armament Research & Development Command, Aberdeen Proving Ground, MD; Natick Research and Development Command, Natick, MA; Mobility Equipment Research and Development Command, Fort Belvoir, VA; Test and Evaluation Command, Dugway Proving Ground, UT; Electronics Research & Development Command, Fort Monmouth, NJ; U.S. Army Medical Bioengineering Research Laboratory, Fort Detrick, MD; Construction



Program Element: #6.27.20.A

DoD Mission Area: #133 - Environmental Quality Research and Development

Title: Environmental Quality Technology

Budget Activity: #1 - Technology Base

Engineering Research Laboratory, Champaign, IL; Waterways Experiment Station, Vicksburg, MS; and Cold Regions Research and Engineering Laboratory, Hanover, NH. Major contractors include: SRI International, Menlo Park, CA; Hercules Inc., Radford, VA; Midwest Research Institute, Kansas City, MO; University of Illinois, Urbana, IL; Mitre Corporation, McLean, VA.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Program objectives and priorities were initially established in FY 1977 by the Army Science and Technology Objectives Guide (STOG). Science and Technology objectives for the environmental quality technology program addressed needs for improvements in the technical areas of environmental and health effects research; environmental monitoring, management, assessment and planning technology; and environmental pollution source reduction, control and treatment technology. Accomplishments in these technical areas have included: establishment of temporary environmental and health effects guidelines for six priority munitions waste compounds, and the initiation of studies on 58 other munitions-related, Army-unique compounds; development of a computer system for aiding preparation and review of environmental impact assessments and statements; development of field survey techniques for pollution detection and analysis; development of munition plant pollution monitoring devices; development of a low polluting, more effective process for purification of Trinitrotoluene (TNT), and a process for removal of explosive wastes from munition plant waste water.

A surfactant treatment for munition plant wastewater was developed yielding an environmentally acceptable discharge. High nitrate in munition plant waste waters was shown to be reduced by a fluidized bed biodegradation process. Methods were developed to regenerate the carbon for reuse in the charcoal filtration of munition plant waste water. Instruments were fabricated and tested to measure acid mists in air and to measure certain organic chemical effects in waste water. A program was begun to compare and evaluate various techniques for munition waste pollution abatement developed in this project and others in order to describe best Available Technology for Implementation by 1984.

2. FY 1979 Program: The TNT purification process redesign is being tested to decrease the amount of pollutants in the effluent. A technique will be completed for the recovery and recycling of isopropanol, the polluting effluent from an alternate TNT purification process. Investigations toward completion of pollution abatement techniques for munition production lines, and studies of the application and economics of each method in order to describe best available technology for abatement of industrial and depot wastes are being emphasized. Disposal methods of excess energetic materials are under development. Improved procedures for environmental assessment, ecological surveys, and the impact of research and development projects at Army installations are in progress. The use of High Pressure Liquid Chromatography and other instrumental techniques for the rapid detection of pollutants in military waste streams are being developed. Microbiological processes to treat waste waters are under further investigation to improve logistics and economics. Ongoing efforts at characterization of waste waters will enable the adequacy of new treatment methods in research to be determined.

Comprehensive criteria documents and health and environmental hazard assessments are being completed on major wastewater components from munitions manufacture, load, assembly, pack and demilitarization operations. Design criteria enabling Army installation sewage

Program Element: #6.27-20.A

DoD Mission Area: #133 - Environmental Quality Research and Development

Title: Environmental Quality Technology

Budget Activity: #1 - Technology Base

treatment plants to comply effectively with new NPDES permits are being established. Preliminary disposal methods for some of the most hazardous wastes at Army depots and industrial plants are under study. Other developments scheduled for completion in FY 1979 include preparation of a DA pamphlet and user manuals for environmental impact assessment, development of procurement specifications for impulse noise monitoring equipment, guide specifications for landfill operations. Studies of techniques for economical recycling of vehicle washrack wastewater are being continued.

3. FY 1980 Planned Program: Efforts will be continued to complete development and selection of the best available technology for abatement of waste streams from Army munition plants and depots. Studies will be completed on landfill disposal of sludges from sulfide precipitation of electroplating wastes. Studies will be performed on munitions manufacturing processes to optimize water reuse while meeting effluent discharge guidelines. Physical treatment methods such as catalytic flocculation, coagulation/oxidation, surfactant separation and sulfide precipitation will be studied and evaluated for application to munition and depot waste streams. In environmental and health criteria development, emphasis will be on criteria development for water and air pollutants related to the manufacture of new smokes/obscureants, munitions wastes from new or modified manufacturing and/or treatment processes, and toxic/hazardous wastes unique to the Army. Expanded studies to determine what happens to waste compounds in the environment will be an important part of criteria development, along with continuing chronic mammalian toxicology studies and aquatic bioassays of Army unique waste compounds. Other efforts will involve completion of computer aided procedures for predicting noise impacts from military installations; design guidance for vehicle washrack wastewater recycling systems and a handbook for guiding Army resource managers in protection of vegetative and wildlife resources from Army operations. The in-house personnel required to support the program include 112 professionals and 33 support.

4. FY 1981 Planned Program: The planned FY 1981 program involves completion of the investigation of abatement techniques for munition production wastes including micro-filtration, regenerative carbon absorption and evaluation of specific applications and economics; pilot methods for disposal of excess energetic materials by incineration, recycling, or conversion to useful energy sources; development of physical treatment methods for military waste streams by Atomized Suspension Technique, coagulation/oxidation, and other promising techniques; verification of application of improved ecological survey procedures for assessment of new pollution abatement techniques, and in full characterization of waste streams to determine adequacy of treatment and accuracy of monitoring techniques.

Efforts in environmental and health effects research will continue to give priority emphasis to criteria development for water and air pollutants associated with the production of new smokes/obscureants, munitions demilitarization, and hazardous/toxic waste disposal. Other planned accomplishments include: completion of computer routines and acquisition of data base information for a pollution abatement management system; design concepts for an installation noise warning system and source identification techniques and mitigation procedures for oil pollution control at Army installations.

5. Program to Completion: This is a continuing program.

# FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.22.A  
DoD Mission Area: #132 - Training and Personnel Technology

Title: Manpower, Personnel and Training  
Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
A791	TOTAL FOR PROGRAM ELEMENT Technology for Improved Manpower and Personnel Management and Training	4001	4786	5918	6594	6594	

## B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:

- User Problem:** The Army needs very capable people, and requires a realistic, long-range recruiting and retention program to insure that the Army is adequately manned. Furthermore, these people must achieve individual and team skills in order to insure a combat effective Army.
- Objectives:** (a) Improved prediction of present-day and future manpower and personnel requirements and availability; (b) improved individual and crew/team/unit operational proficiency and cost effective training; (c) improved recruiting, selection, and personnel assignment.
- Products:** Technology for better predicting aptitude distributions of present-day and future enlistees. Training technology data base for Army training and evaluation programs (ARTEPs). New concepts for operator maintenance training. Requirements for refresher training. Methodology for analyzing cost effectiveness of training alternatives.
- How Used:** This work provides a scientifically sound basis for specific personnel screening tests such as the Military Applicant Profile and the Armed Services Vocational Aptitude Battery. It forms the basis of tests for selecting Army recruiters, aviators and other military occupational specialties. This program furnishes the technological foundation for the Army Skill Qualification Tests (SQT). Results are used to reduce costs and improve effectiveness and leadership. This research is also used by the Office of the Assistant Secretary of the Army for Manpower and Reserve Affairs (ASA (M&RA)) and the Deputy Chief of Staff for Personnel, (DCSPER), Department of the Army, in directing policy, personnel support programs and future personnel research to determine the Army's total requirements for skilled soldiers and training of these soldiers.

**BASIS FOR FY 1980 RDT&E REQUEST:** Increased research supports the Army's need to reduce personnel and manpower costs by providing improved personnel acquisition procedures; personnel screening to reduce attrition; improving individual training in service schools and combat unit training; retaining quality soldiers; and improving personnel management policies. Special emphasis must



Program Element: #6.27.22.A  
 DoD Mission Area: #132 Training and Personnel Technology  
 Title: Manpower, Personnel and Training  
 Budget Activity: #1 - Technology Base

be given to reducing the number of soldiers not completing their first term of service and to developing new programs for increasing enlistment, re-enlistment, retention and training for Reserve Components.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL BUDGET REQUESTS: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
NOTE Funds (as shown in FY 1979 submission)	4000	5116	4354	Continuing	Not Applicable

Funding changes reflect program restructuring to meet Congressional guidance.

E. OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.27.22.A

DoD Mission Area: #132 - Training and Personnel Technology

Title: Manpower, Personnel and Training  
Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** This program provides research on personnel management and training technology required to maintain the Army's readiness for combat. Research is accomplished on Army problems through field and laboratory evaluations. Research will be continued and expanded to provide technology for estimating total manpower and personnel costs associated with future weapons systems and evaluation of readiness of individuals and units for combat. Research will also focus on estimating aptitude distributions for soldiers, selection of successful recruiters, and improved operational proficiency of armor, artillery, infantry and air defense crews/teams/units. An improved method to assess the effectiveness of leadership on soldier attitude, aspirations and success will be completed.

**G. RELATED ACTIVITIES:** This effort is coordinated with Air Force Personnel Utilization Technology, P.E. 6.27.03F; Navy Personnel Support Technology, P.E. 6.27.63N; Training and Utilization in Military Systems, P.E. 6.37.43A; Training and Simulation Technology, P.E. 6.22.05F. Interservice coordination is assured through Department of Defense sponsored topical reviews, annual budget and apportionment reviews, tri-service participation in preparation of Technology Coordinating Papers and committees in such areas as aptitude testing.

**H. WORK PERFORMED BY:** Contractors include: Human Resources Research Organization, Alexandria, VA; Applied Science Assoc., Inc., Valencia, PA; Advanced Research Resources Organization, Alexandria, VA; Personnel Decisions Research Institute, Minneapolis, MN; Human Science Research, Inc., McLean, VA. More than half of the funds expended for contracts are for competitive procurements. In-house units distributed at Ft Bliss, TX, Ft Hood, TX, Ft Leavenworth, KS, Ft Rucker, AL, Ft Knox, KY, Presidio of Monterey, CA, Ft Benning, GA, Ft Sill, OK, Ft Benjamin Harrison, IN and Germany.

#### 1. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS

1. **FY 1978 and Prior Accomplishments:** Past research has produced (a) technology for selecting tank gunners with resultant increase in tank gunnery performance; (b) performance-based testing for the Army's Skill Qualification Tests (SQT) program; (c) technical documentation for preparing and using Soldier's Manuals and Skill Performance Aids; (d) Instructions for developing, maintaining and motivating soldier skills in units; (e) training program for cross-training tank crews that uses non-armor MDS as tank crews; (f) adaptation of specialized training technology to training in schools and units through Training Extension Courses and Instructional Systems Development; (g) develop pilot model to measure effects of command leadership on organizational processes, organizational climate, communications effectiveness and combat readiness.

2. **FY 1979 Program:** Develop criteria for measuring the effectiveness of personnel management policies and procedures. Special topics, such as personnel turbulence, malassignment, factors influencing attrition and retention in active and Reserve forces will be evaluated. Develop measures for assessing quality of personnel, training, recruiting and accessioning for the Reserve components. Produce procedures for determining when and how to provide refresher training for skills. Develop a training program for critical maintenance skills. Determine requirements for selecting console operators for Air Defense units. Develop a training program for TRADOC for the M60A3 and the XM-1 tank crews. Develop training program for retaining aviation skills in operational aviation units.

Program Element: #6.27.22.A

DoD Mission Area: #132 - Training and Personnel Technology

Title: Manpower, Personnel and Training

Budget Activity: #1 - Technology Base

Develop methodology to assess cost/effectiveness of the Army's Organizational Effectiveness (OE) program. Develop program requirements for training small unit commanders.

3. FY 1980 Planned Program: Develop technology to help quantify total manpower and personnel requirements for new Army systems. Develop and evaluate selection and classification measures for crew positions. Develop personnel standards and tests for Army weapons systems for use in recruitment and assignment of personnel. Develop measures of unit readiness and deployability based upon individual performance and unit training. Validate methodology for predicting skill decay rates. Initiate research on methods for conducting refresher training in units. Conduct research and development of technology for retaining flight skills. Conduct research and development in support of TRADOC on training programs for the M60A3 and the XM-1 tanks. Develop personnel management training program for small unit commanders. Relate organizational leadership to communications effectiveness, decision making, organizational attrition, delinquency rates, and unit effectiveness. Analyze duties of current Army Organizational Effectiveness (OE) staff officers and non-commissioned officers to identify which skills are best utilized in the field. A total of 60 professional and 30 support personnel are involved in this effort.

4. FY 1981 Planned Program: Develop new technology for determining and presenting information on Army positions available to prospective recruits. Conduct research on procedures for assigning officers and enlisted personnel to combat crews/teams. Conduct research and development on the DoD Computer Adaptive Testing program. Conduct research to support implementation of personnel management at company, battalion and brigade levels. Develop techniques for analyzing competence in interpersonal skills. Evaluate procedures for supervisors to administer individual performance tests in units. Validate performance criteria for specified tasks. Develop maintenance training concepts. Evaluate effects of organizational structures on mission performance.

5. Program to Completion: This is a continuing program.



# FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.23.A

Title: Clothing, Equipment, and Shelter Technology

DoD Mission Area: #131 - Medicine and Life Sciences

Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	<u>TOTAL FOR PROGRAM ELEMENT</u>	<u>3005</u>	<u>3450</u>	<u>4397</u>	<u>7219</u>		<u>Not Applicable</u>
AN98	Clothing and Equipment Technology	2695	3085	3295	5981	Continuing	Not Applicable
A427	Tactical Rigid-Wall Shelters	310	365	1102	1238	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Exploratory development (ED) efforts in this program are oriented to correcting mission deficiencies in combat clothing, individual equipment, and support equipment in order to increase the soldier's effectiveness and provide protection for him against battlefield hazards and the natural environment. Clothing is needed to provide comfort for both normal and extreme climatic conditions and, in specific cases, to provide camouflage, ballistic protection, chemical protection, and flame and thermal resistance. Modern camouflage must decrease the probability of detection; new synthetic fibers of unusual protective power can be predicted, and new dyes and weave patterns can be expected to provide passive defensive protection against many modes of enemy surveillance. Ten seconds protection is needed to allow escape from a burning vehicle such as tanks; modern fabrics hold promise of meeting this need. ED in tactical rigid-wall shelters is part of a Department of Defense effort to meet International Organization for Standardization (ISO) requirements and reduce the proliferation of tactical shelters and special purpose vans. ED in field tentage will correct deficiencies in current tentage by providing a family of general purpose field tentage which provides mobility, habitability, and unobstructed floor space. Work on organization field service equipment is to decrease cost of operation while improving efficiency.

C. BASIS FOR FY 1980 RDT&E REQUEST: To conduct research pertaining to the development and improvement of fibers, fabrics, materials, new design applications, camouflage (dyes and technology) for clothing, personal equipment and field service support equipment to increase the survivability of the combat soldier on the battlefield against projected threats.

Program Element: 06.27.23.A Title: Clothing, Equipment, and Shelter Technology  
 Sub Mission Area: 0131 - Medicine and Life Sciences Budget Activity: 01 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
NOTE					
Funds (as shown in FY 1979 submission)	3025	3450	3930	Continuing	Not Applicable

The substantial increase in funds for FY 1980 contained in this Congressional Descriptive Summary is in Project A427 (Tactical Rigid-Wall Shelters) and reflects steps to apply hardening techniques to shelters. By trade-off analysis, all possible combinations of the present state-of-the-art materials applicable to tactical shelters will be reviewed to determine what degree of protection can be obtained against a nuclear, biological, and chemical (NBC) threat and from a conventional threat.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.23.A

Title: Clothing, Equipment, and Shelter Technology

DoD Mission Area: #131 - Medicine and Life Sciences

Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** This program is designed to improve human performance, environmental protection, and personal comfort; reduce the weight of soldier's clothing and equipment; upgrade levels of protection against chemical agents, flame, and fragmentation threats; investigate countermeasure systems that provide camouflage of the individual soldier against electro-optical devices; and explore the use of new materials and designs to protect the eyes against nuclear flash, laser, and ballistic threats. Also included are efforts to improve field service equipment, field life support facilities, tactical rigid-wall shelters, and the development of design criteria for field shelters.

**G. RELATED ACTIVITIES:** Related research is conducted by coordination with each of the other Services who develop their own Service-related clothing and individual equipment items. Coordination and liaison is accomplished by the US Army Natick Research and Development Command personnel. The exploratory development (ED) efforts in clothing and equipment move to advanced development (AD) under Program Element (PE) 6.37.47.A, Soldier Support/Survivability, and to engineering development under PE 6.47.13.A, Combat Feeding, Clothing and Equipment. AD in tactical rigid-wall shelters is performed in Project D428, Tactical Rigid-Wall Shelters of PE 6.37.26.A, Combat Support Equipment. Engineering development is conducted in Project D429, Tactical Rigid-Wall Shelters of PE 6.47.17.A, General Combat Support.

**H. WORK PERFORMED BY:** The major in-house effort is performed by the US Army Natick Research and Development Command (NARADCOM), Natick, MA. Other Government activities involved are US Army Aeromedical Research Laboratory, Ft Rucker, AL; US Army Materials and Mechanics Research Laboratory, Watertown, MA; and US Army Chemical Systems Laboratory, Aberdeen Proving Ground, MD. Potential contractors include: Fabric Research Laboratory, Dedham, MA; Calspan, Buffalo, NY; Battelle, Columbus, OH; Teledyne Micrometricals, San Diego, CA; Monsanto, St. Louis, MO; Kimberly-Clark, Neenah, WI; West Point Pepperell, Inc., New York, NY; Burlington Industrial Fabrics Company, Rockleigh, NJ; Southern Research Institute, Birmingham, AL; Goretex, Elkton, MD; and Microfibers, Pawtucket, RI. Value of contracts is approximately \$600,000.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Contract was awarded to procure liquid cooled garments for in-house evaluation. A psycho-physical study of the factors that relate to the design of camouflage patterns was completed and published. The analytical design of multi-layer thin films to lower surface emissivity of textile-like structures was completed. A series of reports on the anthropometry of the women of the US Army was completed and published. A contract to develop sealed filter cells for application to eye protective devices was awarded. An experimental test method was developed to impact individual textile yarns ballistically and to measure the material reaction in quantitative units of stress, strain, and time. Various fibers, materials and combinations were evaluated for application to chemical/biological (CB) clothing. Computerized colorant programs were validated with excellent results. Development of a statistical method to evaluate results of a color-matching experiment was initiated. Concepts of alternative fabrics and fabrication techniques for pressurized shaped structural beams ("air beams") were started. Completed analysis shows that frame and panel construction is best for near-term application in tactical rigid-wall shelters.



Program Element: #6.27.23.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Clothing, Equipment, and Shelter Technology

Budget Activity: #1 - Technology Base

Work was initiated to evaluate panel bonding requirements, to predict response of shelters to static and dynamic loads, to evaluate analytical and experimental stress distribution on sandwich panels and frame and panel structures, and to analyze specific hardware problems. Investigations were initiated on response of panels to thermal stress and on methods of nondestructive testing.

2. FY 1979 Program: Complete investigation of improved charcoal binders and formulations, and material fabrication procedures for standard chemical warfare protective clothing. Publish joint service technical plan for chemical/biological (CB) protection in final form. Assess physiological benefits to individuals using conductive body cooling while performing heavy work in hot/dry and hot/wet environments. Issue report on the mental and psychomotor performance of men under high temperature and humidity conditions; begin investigation of same on women. Complete research on materials for infrared (IR) suppression and develop means of combining it with fabrics to produce sufficient quantities for field evaluation. Initiate research or methods for painting camouflage patterns on polyaramid (Kevlar and Nomex) fabrics. Develop capability to perform analysis of the threat posed by multi-spectral photography and laser devices. Complete preparation of military handbook on anthropometry. Further analyze data from women's survey (head, face, and strength measurements) for application to jointly used clothing and equipment. In area of eye protective devices, evaluate properties of hybrid static/dynamic filter system incorporating band-pass filters and various photochromic materials. Complete work on composite frames for general purpose (GP) tentage testing. Complete the mechanical property measurements on commercial nylon and polyester fabric; document the data and their analysis in terms of fabric construction factors. Initiate studies on design features such as flaps, liners, or alternative thermal insulating techniques, closures, floors, reflective coatings, vents, etc., to assess their relative effectiveness in improving habitability in field tentages. Complete contract on determination of psychological comfort of polyester and polyester/wool fabrics. Complete characterization, and scanning electron micrograph (SEM) and X-ray analysis of ultra-violet (UV) degraded and ballistically impacted Kevlar yarns. Initiate energy absorption analysis of varied textile structured forms at selected ballistic impact velocities. Initiate research in computerized colorant formulation for coloration of new or special purpose textile fabrics and for fiber blends for clothing, equipment, and shelter systems; analyze perceptual data to determine dispersion in visual response. In area of tactical rigid-wall shelters, complete analytical and experimental stress analysis work on two test models. Continue work on nondestructive testing methods and on effects of environmental stress. Initiate research to determine response of shelters to dynamic loads including blast loads, to develop protection against NBC/ballistic threat, and to investigate fabrication techniques for end and floor panel structures in place of present welding.

3. FY 1980 Planned Program: Continue Exploratory Development (ED) of activated carbon fiber yarn and fabrics from petroleum pitch, viscose rayon, and polyacrylonitrile and incorporate these materials into textile composites for chemical protection. Obtain quantity of fabric treated to reduce sweat poisoning and evaluate in garment form. Select best candidate phosphazene rubber materials for evaluation in actual end item application. Complete contract for solid core sheathed fiber containing activated carbon. Initiate ED on new concepts to incorporate multiple protective capabilities (ballistic, flame, chemical, etc.) into a single item of combat clothing with the objective of significantly reducing the weight and bulk of standard clothing without degrading protective qualities. Complete analysis of terrain spectral reflectance characteristics to determine the

Program Element: #6.27.23.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Clothing, Equipment, and Shelter Technology

Budget Activity: #1 - Technology Base

reflectance requirements and allowable tolerances for ideal camouflage in verdant and arid areas. Initiate design concepts for aircrew armor system. Continue to evaluate/implement US Army Human Engineering Laboratory findings from fitting and sizing studies of men's field clothing, and how they can be adopted/utilized for women. Initiate research on the energy absorptive properties of thin materials for head/neck/face protection. Continue exploratory development (ED) in response of materials to high energy sources. Complete analysis of correlative field failure of materials. Continue ED on research in fibers and fabrics for ballistic protection by completing analyses of transient deformation and the effects of yarn structure and modification. Develop computer program and laboratory procedures to dye specific tolerance ranges with high precision for comparison of perceptibility and acceptability. Complete studies on fabric concepts for general purpose (GP) tentage, complete evaluation of design features, initiate design of modular tentage for improved habitability, and continue research on fabrication of "air beams." Complete concept work of space heaters and initiate concept design for field latrine/bath/laundry/waste disposal systems. Continue ED in area of tactical rigid-wall shelters by completing stress analysis on one-side expandable shelter; continuing efforts on nondestructive testing and on protection against (nuclear, biological, and chemical) NBC/ballistic threats, and designs to meet protection requirements for C3 (command, control and communications) and other specific field functions. This program involves 69 professional and support personnel.

4. FY 1981 Planned Program: Intensify ED research on fibers and fabrics for chemical protection; chemical biological (CB) protective materials will be screened for handwear, footwear, and torso applications with the goal of attaining the technological capability of a complete protective combat uniform. Test prototype clothing concepts with multiple protective capabilities. Develop a strong psycho-physical basis for research on camouflage materials and methodology. Based on earlier research, design and evaluate in the field a total broadband camouflage system, including radar and thermal suppression for personnel. Initiate ballistic evaluation of candidate materials and conduct research on the threats of overpressure, spall, blast, and trauma in area of head/neck/face protection. Evaluate new commercial materials for flame-retardant properties for military applications. Initiate evaluation of physiological protective materials in prototype configuration; complete characterization, and scanning electron micrograph (SEM) and X-ray analysis of ultra-violet (UV) exposed and ballistically impacted Kevlar fabrics. Initiate research to evaluate materials which can simultaneously attain ballistic efficiency and high insulative values for application to cold weather clothing. Initiate work to improve efficiency in dyeing materials and fabrics. Initiate research on chromatic adaptation as it relates to uniforms. With relationship to tactical rigid-wall shelters, document completed analytical and experimental stress analysis work, continue work on NBC/ballistic protection, and continue design work and nondestructive testing methods. Investigate means of moving shelters for complexing.

5. Program to Completion: This is a continuing program.

FY 1980 RITE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.24.A Title: Joint Services Food System Technology  
 Bob Mission Area: #131 - Medicine and Life Sciences Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ In thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	8044	6000	7453	9334		Not Applicable
AI99A	Analysis and Design of Military Feeding Systems	2365	1880	2802	2247	Continuing	Not Applicable
AI99B	Subsistence Technology	2678	2487	3583	4290	Continuing	Not Applicable
AI99C	Food Service Technology	51	33	50	360	Continuing	Not Applicable
AI99D	Radiation Preservation of Food	2950	1600	1018	1000	Continuing	Not Applicable
AI99E	Military Nutrition Technology	0	0	0	1437	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Insuring a safe, wholesome, and nutritious food supply for the soldier is a basic responsibility of all the Services under conditions of combat, emergency mobilization, and peacetime training. While the current US Commercial Food System provides a high quality food supply it is based on a highly developed and sophisticated distribution system with great reliance on perishable food components. In many of the actual and potential overseas military mission (deployment) areas, the CONUS commercial food system cannot be projected along with combat forces without extensive reliance on refrigerated shipping and the need for construction of refrigerated warehouses and handling facilities. The commercial food industry is oriented on the relatively easy trip from farm to supermarket while militarily we must have operational rations which may be shipped almost anywhere, be stored under adverse conditions for long periods of time, and still be affordable, safe, and taste reasonably good to soldiers, sailors, and airmen. This program provides for studies of food preservation methods, food packaging, and protection, food storage preparation, and serving equipment, and overall food management, supply and service systems for the Army (USA), Navy, (USN), Marine Corps (USMC), Air Force (USAF), the Defense Logistics Agency (DLA), and is part of the Department of Defense (DOD) Food Research, Development, Testing and Engineering (RDT&ENG) Program managed by the Army for the DOD. Wholesome, nourishing food is critical not only to the maintenance of physical health and well being but is of very high morale value especially when operations are conducted in hostile and hazardous areas. The logistical resources required to support a highly acceptable combat food service system represent a significant portion of the total force, requiring a complex transportation, storage, and distribution system; a labor intensive force with special skill requirements and a high degree of management attention to keep the system in order. The objective of this Joint Service program is to streamline the overall requirements of the DOD food system consistent with available and projected food technology capabilities from the US and foreign food industry, supplemented with in-house developments where unique military food systems requirements cannot be met.



Program Element: #6.27.24.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Joint Services Food System Technology

Budget Activity: #1 - Technology Base

C. BASIS FOR FY 1980 RDTE REQUEST: This program consists of four technical areas as indicated in paragraph A. Project AH99A, Analysis and Design of Military Feeding Systems, provides for continued analysis and design of an Army (USA) and Marine Corps (USMC) Field Food Service System to include USMC Base Food Service operations, and Navy (USN) Food Service Operations Afloat. Project AH99B, Subsistence Technology, provides for continued development effort to increase storage life, maximize nutrient retention and soldier acceptability, reduce weight and volume of ration components; improve packaging systems which includes increased insect resistance. It also includes design of improved insect control measures for military subsistence warehouses; control microbiological hazards in prepared stored foods; and determining methods for reducing spoilage of fresh fruits and vegetables (e.g., losses in worldwide lettuce shipments by Defense Logistics Agency (DLA), last year amounted to approximately 1,285,000 pounds or 8% of the total amount shipped. Estimated value of this annual loss is \$750-800 thousand for lettuce alone). Project AH99C, Food Service Technology, provides for equipment development, and feasibility studies to support the system studies listed above and exploratory efforts in heat transfer for improved energy efficient cooking/baking methods. Project AH99D, Radiation Preservation of Foods, provides for development of irradiated food preservation technology and support to the wholesomeness feeding tests of irradiated chicken meat.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Costs
					Not Applicable
	7969	8327	8850	Continuing	

Significant differences between these submissions are mainly related to changes in the scope and objective of the irradiated food program. A decision has been made to limit future irradiated food research to a demonstration of the wholesomeness of irradiated chicken meat. As a result the technical base effort has been scaled down. Congressional action reduced the FY 79 request which was based on the higher level of effort designed to obtain Food and Drug Administration (FDA) approval of irradiated beef, ham, and pork as well as chicken.

E. OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.27.24.A Title: Joint Services Food System Technology  
DoD Mission Area: #131 - Medicine and Life Sciences Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: This program includes the exploratory development programs conducted by the Army as Executive Agent for the Department of Defense (DOD) Food Research, Development, Testing and Engineering (RDT&ENG) Program for all the Services and the Defense Supply Agency (DIA). Food service logistics in support of combat operations is characterized by the requirement for transportation of large volumes of relatively lightweight materiel, some of which requires special handling (i.e., controlled temperature transportation and storage); special packaging for protection from the environment, insects, rodents, microbiological contamination, and less than optimum handling in the combat zone, and labor intensive operations requiring special skills in the final preparation and serving steps. The maintenance of the current Food System has been required to provide a level of food quality unattainable through the use of packaged "ready to eat" operational rations alone. The activities under this program have the ultimate objective of reducing this logistical burden while maintaining an undiminished level of soldier, sailor, and airman food acceptance. Exploration of alternatives to current practices include minimizing labor requirements by using improved food preparation equipment in the field, minimizing labor and skill requirements by use of fully prepared "convenience type" foods, minimizing transportation weight and space requirements by food dehydration and compression techniques, increased storage stability to reduce costs of maintenance and rotation of prepositioned war reserve stocks, and reducing volume of packaged foods to meet space limitations in Navy (USN) ships and thereby permit to decreased frequency of replenishment and increased mission length. While the primary emphasis in this program is combat support oriented, collateral efforts to reduce garrison (fixed) dining facility costs are also conducted to include cost reductions where possible in the DIA worldwide mission to procure, store, and ship subsistence for military customers.

G. RELATED ACTIVITIES: Work conducted in this program is part of the DOD Food RDT&ENG program which also has projects in the following areas: Program Elements 6.11.02.A, Project AM52, Basic Research in Support Equipment for the Individual Soldier; 6.37.47.A, Project D610, Food Advance Development; 6.47.12.A, Project D147, Wholesomeness Testing of Irradiated Foods; and 6.47.13.A, Project D548, Military Subsistence Systems. This is a coordinated joint services program and there is no duplication of effort within these project elements or in any other services' request.

H. WORK PERFORMED BY: The majority of effort is conducted by the US Army Natick Research and Development Command, Natick, MA. Other Army and government laboratories providing assistance are the Letterman Institute of Research, Presidio of San Francisco, CA; The Construction Engineering Research Laboratory, Champaign-Urbana, IL; and the Regional Laboratories of the Department of Agriculture. Also various colleges and universities perform work in this program such as University of Nebraska, Lincoln, NE; Bowling Green University, Bowling Green, OH; Massachusetts Institute of Technology, Cambridge, MA; Boston University, Boston, MA; and Texas A&M University, College Station, TX. Other institutions which have been involved in contract work are National Academy of Science, ARA Food Services, Philadelphia, PA; General Electric Co., Schenectady, NY; and Ralston Purina Corp., St. Louis, MO.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Potential storage life of packaged combat rations and meal components has been increased by processing methods which reduce oxidation and other deteriorative processes thus contributing to an overall reduction in subsistence lost in storage and shipment; completed systems concept for Hospital Food Service System for 1990, tailored a

Program Element: #6.27.24.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Joint Services Food System Technology

Budget Activity: #1 - Technology Base

prototype "fast food" system on the USS Saratoga to improve sailor morale, effectiveness and nutrient intake which will be extended to all fleet carriers; Initiated Marine Corps (USMC) food service system for USMC combat forces embarked on container ships of the Merchant Marine Fleet; Investigated feasible alternatives for US Air Force (USAF) Base Food Management and Mobilization Food Service.

2. FY 1979 Program: Continue storage, stability, processing techniques, and human acceptance studies of new and modified subsistence items and rations; complete analysis and design of USA (Army) and USMC Field Feeding System; continue evaluation and design of a USAF Food Service Mobilization System; continue development of the USMC lightweight assault food packet; continue analysis and design of USA Hospital Food Service System; complete analysis of USMC Base Food Service System; continue insect resistant packaging studies; continue design and analysis of Navy (USN) Food Systems Afloat; complete development of chemical dispersal system for subsistence warehouse insect control; complete microbiological studies of USAF missile site food quality; complete development of a system for control of insects in storage areas where fumigation is not possible; continue studies of cooking/baking heat transfer methods; continue development of improved flexible packages and multi-serving containers to include prototype food improvements; and continue work to reduce losses from spoilage in fresh fruits and vegetables.
3. FY 1980 Planned Program: Continue storage, stability, processing technique, and human acceptance studies of new and modified subsistence items and rations; continue analysis and design and development of USAF Food Service Mobilization System; complete analysis and design and prototype development of Army Hospital Food Service System Operations; continue studies on insect resistant food packaging; continue analysis and design and prototype development of Navy Food System Afloat; develop improved food packaging methods consistent with current handling and storage techniques; continue development of new multi-serving packages and combat food item prototype development; continue cooking/baking equipment studies; initiate development of improved food service system for remote or isolated locations; and initiate combustion technology program for improvement of field stoves and cooking equipment to include use of future alternate fuels. There are 87 professional and 55 support personnel in this program.
4. FY 1981 Planned Program: Continue storage, stability, processing techniques, and human acceptance studies of new and modified subsistence items and rations; complete USMC garrison feeding studies and prototype development; complete USAF Mobilization System Study; complete design work on Food Service Systems for the Army and USMC; continue shipboard feeding systems design/development; continue development of methods to reduce food losses for Defense Logistics Agency; continue remote/isolated site food system development; and initiate field food service sanitation technology program to reduce hazards of microbial contamination of military subsistence materiel. A new technical area, AU99E (Military Nutrition Technology), will be included in the FY 1981 budget request to provide for militarily unique nutrition and food hygiene research to support the development of new military food systems.

5. Program to Completion: This is a continuing program.



FY 1980 RDTF CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.25.A Title: Computer and Information Sciences  
 DoD Mission Area: #127 - Information Processing and Display Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	2800	2510	2496	2478		Not Applicable
DY10	R&D in Multicommand Data Systems	1609	2085	1996	2055	Continuing	Not Applicable
A778	Human Factors in Programming	0	175	200	188	Continuing	Not Applicable
AT11	Engineering Software	200	250	300	235	Continuing	Not Applicable
DD51	Telecommunication Software	280	0	0	0	Not Applicable	Not Applicable
D730	Improved Data Effectiveness and Analysis	711	0	0	0	Not Applicable	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supports the Defense System Software Research and Development Technology (DSSRDT) Plan promulgated in September 1977, and the Army Integrated Software Research and Development (ISRAD) Program which was established in 1974. The objective is to conduct coordinated research in areas of the software technology to permit the growth of Army software development from an art to a well structured discipline. The program element includes research into software development techniques which span every phase of the software life cycle as well as techniques to quantify for management the economics of the entire software development/maintenance process. This research will provide a basis for the development of software which will enable the soldier of the future to operate and maintain Army personnel, logistics, engineering, and financial systems. The major thrust of this program is to develop and utilize advances in computer software for near term cost and quality improvements for both DoD weapons and automatic data processing (ADP) systems.

C. BASIS FOR FY 1980 RDTF REQUEST: Research will be supported in new concepts and methods for the development of generalized tools, techniques, and procedures required to satisfy the needs of computer software developers for standard multicommand data processing systems, research in human factors aspects of computer software, and scientific and engineering applications. Develop analytical tools and techniques to monitor and predict computer system performance, control resources, produce future interactive management information systems which employ networks, data base management systems, minicomputers and microprocessors; develop tools and techniques to improve productivity of software development personnel and to increase software reliability. Participate in the DoD development of improved, standard programming languages. Investigate human capabilities and limitations as applied to software development to improve development productivity. Develop an approach for creating interpreters which can operate without change on various commercial and tactical computers. Determine optimum graphics system architecture and costs/benefits ratios on different types of information. Prepare dissemination information for interested DoD elements on the best techniques found for enhancing reliability and transportability of computer software.

Program Element: #6.27.25.A Title: Computer and Information Sciences  
DoD Mission Area: #127 - Information Processing and Display Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
RDTE					
Funds (as shown in FY 1979 submission)	2009	2510	3000	Continuing	Not Applicable

Reduction of \$504 thousand in FY 1980 funding level was a result of reduction in total funds available to the Army. Scope of research was partially reduced in priority share of the Army reduction. The revised increase in FY 1978 RITE funds (\$2009K vs \$2800K) as shown in FY 1980 submission were due to the inclusion of two additional projects in this program element, namely the Telecommunication Software (Project #D051) and the Improved Data Effectiveness and Analysis (Project # D730). Information provided in the FY 1980 studies programs and research-oriented Congressional Descriptive Summaries (CDSs) were improved over that information provided to Congress for the FY 1979 budget request. Accordingly, more detailed information has been provided for planned studies and research efforts which answers the questions - what, why, when, where, and costs involved.

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.25.A Title: Computer and Information Sciences  
DoD Mission Area: #127 - Information Processing and Display Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The production of computer software is recognized to be a costly, labor-intensive activity. The high cost of software is in part a function of inefficient and inaccurate design and programing techniques, which frequently cause schedule overruns and software reliability problems. Thus, software development in the Army could profit greatly from techniques to improve designer and programmer productivity and accuracy. The objective of this computer information engineering and technology program will be to refine, evaluate, and apply advanced software tools and techniques and install an engineering software discipline with rigor similar to that characterizing hardware development programs. In this program, seventeen technological areas of effort (i.e., in support of the Defense System Software Research and Development Technology (DSSRDT) Plan) will be focused on the future management of Army resources in the face of increasing austerity. The program element presently includes the Engineering Software project (6.27.25.A/AT11) of the Office of the Chief of Engineers; the Multicommand Data Systems project (6.27.25.A/DY10) of the US Army Computer Systems Command; and the Human Factors in Programing project (6.27.25.A/A778) of the US Army Research Institute. The Multicommand Data Systems project supports research into new concepts and methods which Application System Developers use in the development of multicommand systems such as the Standard Installation Division/Personnel System (SIDPERS), the Joint Uniform Military Pay Systems (JUMPS), and the Standard Army Intermediate Level System (SAILS) of the Army logistical system. Support of such projects requires research in areas such as life-cycle management, requirements formulation, data base management systems, and secure operating systems. The principal goal of this task is to improve techniques used in the development and maintenance of software in order to improve the Army's ability to manage software development projects, to cost-effectively support different hardware environments, increase the reliability of software systems, and to improve programs productivity. In addition, the major thrust is to enhance standard Higher-Order Programing Languages and data independence and to minimize machine dependence of software.

G. RELATED ACTIVITIES: The Army's Integrated Software Research and Development (ISRAD) program receives support from Project 6.58.01.A/WY29 (Integrated Software). The Multicommand Data Systems project was transferred to this program element from PE 6.58.03.A (Technical Information Activities) in FY 1976. Efforts in this program have application to developments in the Army's Management Information Systems. Participating developing agencies include the Office of the Chief of Engineers, US Army Research Institute, and the US Army Computer Systems Command. Work previously planned by US Army Materiel Development and Readiness Command under this program element has been consolidated with related work in PE 6.27.01.A. Efforts in this area affect and are affected by the Army's cooperative endeavor with the DoD Management Steering Committee for Embedded Computer Resources, and other DoD panels/committees. Continued liaison at the laboratory level and between the US Army's Integrated Software Research and Development Program Working Group and its Navy and Air Force counterparts minimize unnecessary duplication of effort.

H. WORK PERFORMED BY: International Business Systems, Washington, DC; General Electric Company, Arlington, VA; Georgia Institute of Technology, Atlanta, GA; Raven Data Processing, Washington, DC; Federal Data Corporation, Chevy Chase, MD. In-house developing agencies include: US Army Computer Systems Command (USACSC) and US Army Institute for Research in Management Information and Computer Sciences (AIRMICS), Atlanta, GA; US Army Research Institute, Alexandria, VA; US Army Waterways Experiment Station, Vicksburg, MS; US Army Construction Engineering Research Laboratory, Champaign, IL.



Program Element: #6.27.25.A

DoD Mission Area: #127 - Information Processing and Display

Title: Computer and Information Sciences  
Budget Activity: #1 - Technology Base

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: US Army Institute for Research in Management Information and Computer Sciences (AIRMICS): Specific accomplishments in the Multicommand Data System project has included the following key efforts: Reviewed existing languages and methods for requirements engineering; developed a system sketching concept which will result in better requirements formulation, increased traceability of requirements, and systems more responsive to users' needs; completed initial DOD Higher Order Language (HOL) designs, and chose two designs for further development; analysis of portability research has resulted in the development of programmer's aids for portability translation; development of a prototype system for assessing test data quality has begun; a query language using relational concepts in a Back-End Data Base Management System (DBMS) written in COBOL has been implemented on a minicomputer; developed a technique for simulating a DBMS on a minicomputer. US Army Research Institute (ARI): Specific accomplishments in the Human Factors in Programming project has included the following key efforts: designed approach for creating transferable language interpreter software; performed human factors analysis of software development process, and identified critical psychological and human factors variables influencing performance; predicted program debugging performance based on propositional structure of programs; analyzed use of flowchart and program design languages (PDLs) as design documentation methods. US Army Waterways Experiment Station (WES): Specific accomplishments in the Engineering Software project has included the following key efforts: Evaluated refresh tube systems selecting one suitable for Army color graphics, and evaluated for incorporation into Graphic Compatibility System (GCS) features of other graphic systems and SIGGRAPH. Developed a complex solid geometry display generator. Modified drum clotting procedure to enable optional cathode ray tube (CRT) plotting. Developed procedures for error editing and storage optimization. Tested advanced scanner procedure, document and tested automated documentation system. Disseminated instruction on proper interpretation interval arithmetic analysis, and developed standards for arithmetic hardware unit for the requirements analysis.

2. FY 1979 Program: Accelerate the use of new proven software advances by Program Managers and defense contractors. Within the Multicommand Data Systems project, continue to develop and implement tools and techniques in the areas of portability, interchangeability, security/privacy, verification/validation, and programming languages; and extend the Data Base Management System (DBMS) concept to multicommand systems. The goal is to: develop and demonstrate prototype system for assessing test data quality; formally define a Standard Higher Order Language and develop prototype compiler; develop a decision-aiding system for software development management using fullscreen interactivity and other graphics capabilities; develop tools and techniques for simulation of distributed DBMS; determine user needs and requirements for advanced Management Information System (MIS); initiate research projects which identify applicable technology leading to several alternative solutions to the Army's MIS needs; develop methodology for interactive specification of user requirements to produce Detailed Functional System Requirements (DFSR) and technical design of entire computer environment to support user requirements. Within the Human Factors in Programming project continue to analyze software design methods and programming methods and practices for input to tradeoff decisions; perform research on algorithm development and procedure specification. Within the Engineering Software Project continue to add color CRT modules and test refresh tube systems. Test and document solid geometry display method. The key areas of investigation in the Engineering Software project are to develop and test generalized evaluation and validation programs and incorporate parallel and pipeline processing techniques into the graphics compatibility system which was initiated in FY 1978.

Program Element: #6.27.25.A  
Dob Mission Area: #127 - Information Processing and Display  
Title: Computer and Information Sciences  
Budget Activity: #1 - Technology Base

3. FY 1980 Planned Program: The research program will focus on advanced management information concepts for both Multi-Command Data Systems and Army automated battlefield systems. The goal is to investigate procedures and methods for development of automated systems which are both responsive to user needs and cost-effective. This research will be conducted principally by academic and commercial activities. A limited number of in-house personnel, 27 professional and support staff in the US Army Institute for Research in Management Information and Computer Science (AIRMICS), will manage the research of these external sources and technology transfer within the Army/DOD. Some affiliated research will be conducted in-house. Within the Multicommand Data Systems Project continue to develop and implement tools and techniques in the area of requirements formulation, system sketching, life-cycle management, performance prediction simulation, distributed data bases, microprocessor/minicomputer experimentation, software reliability, programming languages can compilers. The key areas of investigation in the US Army Research Institute (ARI) Human Factors in Programming project are to develop methods for measurement of programmer performance, develop job/performance aids to facilitate algorithm conceptualization; validate and extend techniques to achieve courseware transportability. Within the US Army Waterways Experiment Station (WES) Engineering Software Project the goal is to determine optimum graphic system architecture and cost/benefit ratios on different types of equipment. Prepare dissemination information for interested DOD elements on the best techniques found for enhancing reliability and transportability of computer software.

4. FY 1981 Planned Program: Continue research to produce software development concepts which will provide better management information to Army managers on the most cost effective basis. In-house resources, 27 professional and support personnel, will be used principally to manage and direct a research program by US Army Institute for Research in Management Information and Computer Sciences (AIRMICS) sponsored academic and commercial sources. A limited in-house research effort in related areas will also be pursued. The primary goals in the Multicommand Data Systems Project are to evaluate the employment of new information/electronic technologies for replacement of fielded systems in the 1985-1990 period, continue microprocessor/minicomputer application studies, develop a prototype software quality measurement facility; and conduct extensive distributed data base (network) experiments. The key areas of investigation in the Army Research Institute (ARI) Human Factors in Programming Project are to develop human factors design guide for improved software production; and develop on-line interface aids. Within the WES-Engineering Software Project the primary goals are: Develop and implement a special module for graphic time-sharing support. Evaluate graphic interaction on a test system. Develop mechanism for scientific information storage and retrieval. Design minicomputer-based system for automated collection and integration of test data from analog sensors.

5. Program to Completion: This is a continuing program. Planned activities for FY 1982-85 consist of the following: Publish final report on automated compilation of Digital Data Fields. A mechanism for the storage, retrieval, and dissemination of information on scientific and engineering software will be developed. A minicomputer based data acquisition system will be designed to automate the collection of test data. The system will include analog-to-digital sensors, a processor to control and perform data interpretations, and an output storage medium on which to place the data in a form compatible for further detailed analysis on a larger host system. Develop concept of a special module in a time-sharing operating system to support graphic applications. Implement graphics support module, and evaluate man-machine interaction on testbed system; initiate feasibility

Program Element: #6.27.25.A Title: Computer and Information Sciences  
DoD Mission Area: #127 - Information Processing and Display Budget Activity: #1 - Technology Base

study of providing and supporting computer graphics software tool at all DOD installations. If the requirements technology technique is determined not to be the suitable technique for error analysis, other techniques will be investigated and recommendations will be made for their application and use on short word length machines.



FY 1980 RITE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.26.A  
 DoD Mission Area: #124 - Target Exploitation

Title: Army Support of the Defense Advanced Research Project Agency (DARPA)

Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
	<u>TOTAL FOR PROGRAM ELEMENT</u>	<u>3000</u>	<u>3000</u>	<u>1500</u>	<u>0</u>	<u>0</u>	<u>8487</u>
A557	Defense Advanced Research Project Agency (DARPA) Netted Radars	1500	1500	1500	0	0	5000
D159	Army Support of DARPA Hostile Weapons Locating Systems (HOMLS)	1500	1500	0	0	0	3487

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program funds the Army's portion of a joint DARPA-Army effort addressing techniques for integration, remoting, and netting moving target indicating surveillance radars. These techniques include radar processing, communications, network management, central site processing, and remote terminal data acquisition/display necessary to define the performance and utility of a netted battlefield radar system. This technology program will enable the Army to more efficiently and effectively use surveillance radars to locate hostile targets without interruption. A previous project through FY 1979 funded the Army's portion of an effort to investigate long term solutions to the hostile weapons location problem to ensure the most efficient methods are developed to locate hostile indirect fire weapons in both firing and nonfiring modes.

C. BASIS FOR FY 1980 RITE REQUEST: Conclude this technology effort. Complete development of an experimental prototype netted radar and demonstrate it in the radar net; complete development of advanced netting techniques. Accomplish application studies to assist in establishing the proper role for tactical radar nets within the Army. Transfer to Army for further development.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RITE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Costs
	3000	3000	1500	0	8487

Program element funding has not changed.

Program Element: 06.27.26.A  
DoD Mission Area: 0124 - Target Exploitation

Title: Army Support of the Defense Advanced Research Project  
Agency (DARPA)  
Budget Activity: 01 - Technology Base

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.26.A  
Sub Mission Area: #124 - Target Exploitation

Title: Army Support of the Defense Advanced Research Project Agency (DARPA)

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: In June 1973, the Defense Advanced Research Projects Agency (DARPA) was tasked by the Under Secretary of Defense for Research and Engineering (USIRE) to conduct a research and development program in search of new and improved solutions for the location of hostile indirect fire weapons in both firing and nonfiring modes. The Army was invited, on a cost-sharing basis, to participate in a cooperative five-year program under DARPA lead. A Memorandum of Understanding (MOU) was signed in May 1974 for the Hostile Weapons Locating Systems (HOWLS) effort. The Army portion of this effort terminates in FY 1979. An MOU was signed in September 1976 which formalized the Netted Radar effort. This effort will develop and demonstrate advanced technology for surveillance radars, to include processing, antennas, and mobile terminals.

G. RELATED ACTIVITIES: The primary Army technology base efforts which complement this program are Program Element (PE) 6.27.03.A, Combat Surveillance, Target Acquisition, and Identification; PE 6.27.09.A, Night Vision Investigations; and PE 6.27.32.A, Remotely Piloted Vehicles (RPV) Technology. There is also a relationship between this program and Army work under PE 6.37.04.A, Unattended Ground Sensors (UGS); PE 6.47.29.A, Countermortar Radar; PE 6.47.31.A, Counterbattery Radar; and PE 6.37.19.A, Special Purpose Detectors. These latter efforts provide significant near term improvements, whereas this PE is searching for longer range solutions. A joint DARPA-Army steering group reviews all programs to ensure there is no duplication and that the combined technology base efforts represent the best approach to long term solutions.

H. WORK PERFORMED BY: The US Army Electronics Research and Development Command, Ft Monmouth, NJ, is the lead service activity. Lincoln Laboratory, Lexington, MA, is the primary technical agent for this program element.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: The HOWLS project was initiated in FY 1975. Designed and constructed brassboard Infrared (IR) mortar location system and successfully demonstrated concept; transferred to Army for follow-on effort. A study of projectile tracking radar alternative configuration was completed, and new trajectory determining algorithms were developed and tested; this work was applied to improve ongoing service developments. Designed and built experimental two-color IR sensor; completed ground-based measurement efforts supporting the analysis and acquisition technique development; modified the experimental sensor and conducted airborne measurements and terminal homing seeker simulators. Completed measurements of flash, acoustic, seismic, and radio frequency emissions of firing weapons. Work in flash and acoustics was terminated since other ongoing programs were felt to deal adequately with these; seismic and radio frequency efforts were technically assessed as low payoff and also terminated. The Netted Radar project was initiated in mid FY 1977. Designed and built experimental airborne radar system; initiated data collection supporting detection and classification technique development and analysis. Two AN/PPS-5 radars were modified, and an experimental Radar Control Center was developed to control the radars and display their target data. Prepare for Netted Radar demonstration in FY 1979.



Program Element: #6.27.26.A

DoD Mission Area: #124 - Target Exploitation

Title: Army Support of the Defense Advanced Research Project Agency (DARPA)

Budget Activity: #1 - Technology Base

2. FY 1979 Program: Conclude Hostile Weapons Locating Systems (HOWLS) project. Complete development of real-time processing for airborne radar and conduct demonstrators. Complete development of two-color infrared (IR) guidance techniques. Transfer technology to the appropriate service development agencies. The Netted Radar project will conduct demonstrations of the netted radar concept using the modified AN/PFS-5 radars and the radar control center at Fort Sill, OK, to key Defense Advanced Research Project Agency (DARPA), Army, and Marine Corps personnel. A feasibility prototype netted radar will be developed for integration into the net. Initiate development of advanced netting techniques using data collected from demonstrations.
3. FY 1980 Planned Program: Conclude Netted Radar project. Complete development of the feasibility prototype netted radar, and advanced netting techniques. Incorporate additional sensors and capabilities into experimental net, and demonstrate the above. Accomplish application studies to assist in establishing the proper role for tactical netted radars in the Army. Transfer technology to the Army for further development. There are two professional personnel required to monitor this program at Ft Monmouth, NJ.
4. FY 1981 Planned Program: None. Program completed in FY 1980.
5. Program to Completion: Program completed in FY 1980.

FY 1980 ROTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.27.A Title: Non-Systems Training Devices (NSTD) Technology  
 DOD Mission Area: #132 - Training and Personnel Technology Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ In thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs	Not Applicable
	TOTAL FOR PROGRAM ELEMENT	2050	2750	2955	3726			
A230	NSTD Technology	2050	2750	2955	3726	Continuing	Not Applicable.	

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program element (PE) provides for the exploratory development of Non-Systems Training Devices (NSTD). Non-Systems Training Devices are developed to support general military training, training on more than one item/system, or several different types of equipment, as compared with System Devices that are developed in support of a specific item/system. The mission of today's Army is to be prepared to fight and defeat a potential adversary having a numerical advantage in both personnel resources and firepower. In addition, the Army must be maintained in a continual state of high readiness. There may be no time to intensify training prior to the opening of hostilities, and no opportunity to loose the first battles and still win the war. At the first shot of a future war, the Army must be totally prepared to fight and win. The combat effectiveness of Army personnel is key to both compensating for the numerical imbalance of opposing forces and for maintaining a ready force. This combat effectiveness can only be achieved by innovative, efficient, and results oriented training. Modern technology, manifested in this instance by modern training devices, can provide the means to accomplish this required training. Prior to technology providing the means, the Army could not realistically simulate battlefield conditions in training and, therefore, was unable to provide an environment where leaders and soldiers could gain the experience required to survive and win on the modern battlefield. Studies of casualties in World War II, Korea, and the Republic of Vietnam conclusively show that probabilities of survival improve dramatically as a function of exposure to enemy action. Training device systems can be expected to partially provide the experience and increased effectiveness previously acquired during the first days of exposure to combat when men and materiel were needlessly lost as personnel and units adjusted to the realities of war. The major thrust in the development of new training devices is to develop devices allowing a high transfer of knowledge and experience from the training situation to a combat situation. The Army must train as it is to fight. The increase in combat effectiveness that can be obtained through the use of appropriate training devices has been demonstrated by REALTRAIN, a first generation engagement simulation system. The effectiveness of REALTRAIN has been validated in numerous field exercises. Studies have indicated that units training with REALTRAIN have become significantly more combat effective than units training with previously standard methods. Typical statistics within the studies indicate that units trained with REALTRAIN destroyed 26% more opposing weapons while sustaining 49% fewer casualties. These results reflect progress in meeting the basic challenge of providing learning situations which have the requisite fidelity to require the same decisions and techniques in training as those required in combat. Training devices also offer another potential for improving the effectiveness of

Program Element: #6.27.27.A

Title: Non-Systems Training Devices (NSTD) Technology

DoD Mission Area: #132 - Training and Personnel Technology

Budget Activity: #1 - Technology Base

the Army. Studies have indicated that, due to the inability to conduct refresher training, the proficiency of individuals and units decrease significantly during periods between field or weapons live-firing exercises. Constrained resources preclude a more frequent occurrence of these activities. Training devices afford the potential to simulate aspects of these activities within garrison locations, using minimal space, time, combat equipment, and personnel. Hence, training devices will provide an effective and efficient means to provide refresher training and thereby maintain combat proficiency at a high level. The overall improved combat effectiveness afforded the Army through the use of appropriate training devices could very well be the determining factor in the outcome of future wars. Improved training devices, now available through modern technology, must continue to be developed to allow the training required to prepare United States soldiers to fight outnumbered and win.

C. BASIS FOR FY 1980 RDT&E REQUEST: Continue to develop concepts for incorporating US weapon systems, enemy weapon systems, and exercise control instrumentation into engagement simulation exercises. Research and analyze concepts for the application of computer technology and automated data handling to exercise control systems. Continue the development of selected wide angle visual display systems. Evaluate Electronic Warfare (EW) training device concepts and candidate EW training devices. Continue the development and evaluation of Computer Generated Imagery (CGI) techniques. Continue the exploratory development of training devices to increase the effectiveness of maintenance training. Initiate programs to explore the more effective use of real time feedback in maintenance trainers. Explore approaches for introducing opposing force targets into established firing ranges. Continue research on means to simulate the weapons signature of small arms.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Not Applicable
RDT&E						
Funds (as shown in FY 1979 submission)	2050	2750	3540	Continuing		

This reduced funding in FY 1980 (\$585000) reflects the diversion of funds to higher priority programs.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.27.27.A

DoD Mission Area: #132 - Training and Personnel Technology

Title: Non-Systems Training Devices (NSTD) Technology

Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** This continuing Program Element (PE) provides for the Exploratory Development of training devices which are developed to support general military training, training on more than one item/system, or several different types of equipment. The effort under this PE is directed towards providing a technology base in support of Army training device development. The cost and sometimes reduced effectiveness of training with operational equipment, the lack of sufficient available training areas, and the need for high levels of proficiency to achieve full combat effectiveness requires continuing examination of approaches to simulation and training devices. This PE provides the necessary "front-end" analytical effort required for developments to smoothly transition into Advanced Development and Engineering Development. The PE is structured into six technology areas. (1) The Engagement Simulation Area includes technologies supporting: simulation of a fully integrated battlefield; conduct of large scale, two-sided, force-on-force training exercises; and multi-purpose training devices/simulators for training crew, group, team, and unit interactions. (2) The Visual Simulation Area includes technologies supporting: wide angle, real world tactical displays for crew training; and compact, low cost, interactive visual displays for individual training. (3) The Electronic Simulation Area includes technologies supporting: the expanded application of computer technology to achieve more effective training at a lower cost, and the simulation of electronic effects encountered on the battlefield. (4) The Maintenance Simulation Area includes technologies supporting: a family of hands-on, low cost, self-paced, adaptive maintenance trainers for use at individual and unit levels; and techniques for incorporating audio and visual cues and feedback in maintenance trainers. (5) The Electro-Mechanical Simulation Area includes technologies supporting: dynamic, threat oriented target systems; weapons effect simulation; and laboratory simulation of operational environments. (6) The Training and Human Factors Area includes efforts to: make training objectives more prominent in training device developments, promote and establish safety standards related to training device developments, develop man-machine interfaces that enhance learning.

**G. RELATED ACTIVITIES:** Close coordination is maintained with other services through Training and Personnel Technology Conferences, Topical Reviews, Joint Service Technical Coordinating Group - Simulators and Training Devices, worldwide staffing of Training Device Requirements, and the co-location of the Office of the Army Project Manager for Training Devices (PM TRADE) and the Naval Training Equipment Center (NTEC). The technology/devices developed within this PE normally progress to Non-Systems Training Devices (NSTD) Advanced Development (PE 6.37.38.A) and/or NSTD Engineering Development (PE 6.47.15.A). Related Program Elements are 6.27.22.A, Army Training Technology; 6.22.05.F, Training and Simulation Technology; 6.27.57.N, Training and Human Engineering Technology.

**H. WORK PERFORMED BY:** Primary contractors: Xerox, Pasadena, CA; Farrand Optical, Valhalla, NY; Computer Sciences Corporation, Falls Church, VA; Harry Diamond Laboratory, Adelphi, MD; University of Southern California, Los Angeles, CA; and the Florida Technological University, Orlando, FL. In-house development is performed by Project Manager for Training Devices, Orlando, FL; Naval Training Equipment Center, Orlando, FL; US Army Armament Command, Dover, NJ; and Letterman Army Institute of Research, Presidio, San Francisco, CA.

Program Element: #6.27.27.A Title: Non-Systems Training Devices (NSTD) Technology  
DoD Mission Area: #132 - Training and Personnel Technology Budget Activity: #1 - Technology Base

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Completed research and feasibility studies to determine alternatives for thermal targets. This effort resulted in the distribution of plans for the field fabrication of thermal targets. Completed contract definition efforts to determine the most feasible and cost effective alternatives for the Armor Full Crew Research Simulator (AFCRS). This development subsequently progressed to Advanced Development. Continued major research effort (cooperative effort with the Navy and Air Force) in the areas of wide-angle, laser scanning, and 360° Annular Visual Systems, for the wide field of view capability needed for future flight and tank simulators. Continued to co-sponsor a Letterman Army Institute of Research effort concerning eye safety of low power gallium arsenide lasers. This effort resulted in a new data base supporting a revision to safety standards. Initiated projects to develop devices to simulate the weapons signature of small arms as a substitute for blank ammunition, concentrating on a replacement for high cost 50 caliber blank ammunition. This development has the potential for significant cost avoidance in engagement simulation exercises. Completed a design study of Fresnel virtual image displays. Initiated investigations of Computer Generated Imagery. Initiated efforts in the area of Electronic Warfare (EW) training devices. Identified areas of maintenance training with high potential for improved training at reduced cost and developed an evaluation methodology for maintenance trainers. Initiated Exploratory Development of a Squad Weapons Analytical Trainer (SWAT). In conjunction with the Air Force, initiated Exploratory Development of the Air-Ground Engagement System (AGES). Initiated Exploratory Development of Air Defense Simulators (ADS).
2. FY 1979 Program: Continue the test and evaluation of wide angle laser visual display systems. Continue research on Weapons Effect Technology (WET), to develop devices to simulate the weapons signature of small arms. Portions of this development program will progress to Engineering Development in FY 1980. Continue the research effort on Fresnel Lens. Continue research on Computer Generated Imagery and its application to the simulation of tactical scenes. Continue research on the simulation of a realistic, threat oriented Electronic Warfare (EW) environment. Portions of this development will progress to Advanced Development in FY 1980. Continue the Exploratory Development of a family of maintenance training devices. Complete Exploratory Development of the Squad Weapons Analytical Trainer (SWAT). This development will progress to Engineering Development in FY 1981. Complete Exploratory Development of the Air-Ground Engagement System (AGES) and the Air Defense Simulator (ADS), both of which will progress to Engineering Development in FY 1980. Initiate efforts to develop effective field exercise control systems for engagement simulation exercises.
3. FY 1980 Planned Program: Continue efforts in developing technological approaches that assist in the command and control of field training exercises, and in the collection and processing of training data acquired in engagement simulation exercises. These efforts will aid in obtaining maximum training benefit from engagement simulation exercises. Continue to develop concepts for incorporating the full range of US and enemy weapon systems into engagement simulation exercises. These efforts will aid in creating a highly realistic battlefield environment and thereby allow a high transfer of knowledge and experience from training exercises to the potential battlefield.

Program Element: #6, 27, 27.A  
DoD Mission Area: #132 - Training and Personnel Technology  
Title: Non-Systems Training Devices (NSTD) Technology  
Budget Activity: #1 - Technology Base

Initiate programs to examine an improved next generation of wide angle visual presentation techniques with emphasis on lower cost, higher portability, and greater versatility in tactical scene selection. Continue research on the development of devices to realistically simulate the hostile Electronic Warfare environment. This critical and often neglected portion of the battlefield environment must be accurately simulated to prepare US soldiers to operate and fight in the Electronic Warfare (EW) environment which potential adversaries are fully trained and equipped to produce. Continue Exploratory development of Computer Generated Imagery, developing approaches for reconstituting terrain scenes from the Defense Mapping Agency digital terrain base. This development offers the potential for simulating in a cost effective manner the real terrain in which the Army can be expected to fight. Continue the development of devices to aid in maintenance training. Current maintenance training is primarily conducted on operational equipment. The simulation of malfunctions on operational equipment is a time consuming, costly, and inefficient process. Maintenance simulators will not only allow training to be conducted in a more effective manner but will also allow the operational equipment previously used for maintenance training to be returned to its primary use. Portions of this development will proceed to Engineering Development in FY 1982. Continue development on Weapons Effect Technology (WET). This development will include a family of devices to simulate the signatures of the variety of small arms found on the battlefield. These devices will be a substitute for the currently used blank ammunition and potentially offer significant cost avoidance in the conduct of engagement simulation exercises. Explore approaches for developing improved target systems, with emphasis on lowering costs while increasing the fidelity of threat scenarios. Approximately six professional and three support type personnel will be involved in this program.

4. FY 1981 Planned Program: Complete the development of technical approaches for a first generation family of maintenance and Electronic Warfare (EW) simulators. Initiate programs to provide valid simulation of the full range of conditions expected to be found on the modern battlefield. Initiate programs, in coordination with behavioral scientists, to explore how computer technology can be applied to enhance and reinforce group and combined arms team interactions that will lead to more effective fighting teams. Continue programs to explore techniques for providing improved and adaptive target systems.

5. Program to Completion: This is a continuing program.



# FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: # 6.27.30.A

DoD Mission Area: #153 - Military Engineering Technology Base

Title: Cold Regions Engineering Technology  
Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
<b>TOTAL FOR PROGRAM ELEMENT</b>							
AT42-A	Cold Regions Military Operations	500	540	605	621	Continuing	Not Applicable
AT42-B	Environmental Constraints on Materiel	1100	1180	1857	1700	Continuing	Not Applicable
AT42-C	Cold Regions Maintenance/Operations of Facilities	475	440	375	375	Continuing	Not Applicable
AT42-D	Cold Regions Design and Construction	835	912	840	980	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** The objectives of this program are: (1) to insure that the Army combat Engineering capability is maintained in both a winter temperate zone and in an extreme environment; (2) to develop methods for identifying and evaluating how terrain, climate, and adverse environmental aspects constrain the design and performance of Army materiel; and (3) to develop cost effective techniques and engineering criteria for the construction, maintenance and operation of permanent Army facilities in areas where cold weather presents a problem.

**C. BASIS FOR FY 1980 RDT&E REQUEST:** The FY 1980 request is based on requirements which support the development of employment concepts and doctrine by the Army Engineer Center and School, the Department of Army Materiel Development and Readiness Command (DARCOM), and the military construction, operation and maintenance mission in cold climates of the Corps of Engineers. The first requirement is to provide a cold weather combat engineering capability which will insure that US forces are at least on an equal basis with the winter combat capability of Eastern European countries. The second requirement to support DARCOM is concerned with the design of weapons and equipment employed in winter warfare and under other adverse conditions. The highest priority items in the area require solutions to the problem of icing on the rotor blades of combat helicopters, and insuring that weapon targeting systems remain effective in blowing snow, dust and winter fog. The third objective is to provide a marked reduction in the costs to operate and maintain military facilities in cold regions (northern US, Alaska, Europe). Operation and maintenance costs at Army facilities in cold climates currently average \$84 million above comparable costs for temperate zone facilities; much of this "add-on" cost can be avoided by results derived from research.

Program Element: 46.27.30.A  
 Non Mission Area: #153 - Military Engineering Technology Base

Title: Cold Regions Engineering Technology  
 Rudnet Activity: #1 - Technology Base

D. BASIC FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Not Applicable
RDTE						
Funds (as shown in FY 1979 submission)	2910	3072	3670	Continuing		

The increase in funding for FY 1980 (\$7K) will be used to increase research concerned with realistic battlefield conditions (blowing snow, dust, winter fog, etc.) which can reduce the effectiveness of weapon targeting systems, especially electro-optical (E-O) sensors.

E. OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.27.30.A

DoD Mission Area: #153 - Military Engineering Technology Base

Title: Cold Regions Engineering Technology  
Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND DESCRIPTION:** The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) provides centralized management for this project. Along with CRREL, research is conducted by the U.S. Army Engineer Waterways Experiment Station (WES) and the U.S. Army Engineer Topographic Laboratories (ETL). Research is being conducted in four areas to: (1) Provide U.S. forces with a winter combat capability so that winter conditions can be used to advantage rather than becoming a crippling disadvantage; (2) Overcome environmental constraints on materiel and provide equipment that work as intended in a cold battlefield environment; (3) Maintain and operate Army facilities in northern areas where winter conditions require different methods and techniques; and (4) Develop new design requirements for rehabilitation of existing northern Army facilities to reduce the current energy and maintenance cost penalty attributable to winter conditions. These tasks require a coordinated research approach to solve the problems that cold weather causes on Army facilities, materiel, and operations. This program represents the only Army research investment in these kinds of problems.

**G. RELATED ACTIVITIES:** Related programs are the Civil Works Research and Investigation programs on cold regions hydrology, ice engineering and wastewater management; Program Element 6.11.02.A, Defense Research Sciences, Project AT24, Snow Ice and Frozen Soil; Program Element 6.27.31.A, Military Facilities Engineering Technology, Project AT41, Military Facilities Engineering Technology; Project A896, Environmental Quality for Military Facilities; and Program Element 6.21.11.A, Atmospheric Investigations.

**H. WORK PERFORMED BY:** Approximately 67 percent of work is performed in-house by the U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH. CRREL serves as the managing laboratory for this project, and is the primary performing activity. The remaining portions of the work are performed at the U.S. Engineer Topographic Laboratories at Fort Belvoir, VA; the U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS; the U.S. Army Facility Engineer Support Agency, Ft. Belvoir, VA; and U.S. Army Engineer Division, AK. The performing agencies also contract for research support; contractors include the University of Alaska, College, AK; Colorado State University, Ft. Collins, CO; RAMCO Inc., Arlington, VA; Environmental Research and Development Foundation, Tucson, AZ; and Man-Tech Corp, NJ.

#### **I. PROGRAM ACCOMPLISHMENT AND FUTURE PROGRAMS:**

**1. FY 1978 and Prior Accomplishments:** Reports on ballistic attenuation in snow and fragment penetration in frozen soil have been completed. Techniques for construction of snow fortifications have been completed and distributed; the snow fortification technique provides superior protection and is many times quicker to construct than either previous U.S. methods or current Soviet techniques. A new lightweight mortar baseplate for use in snow has been designed; a series of 10 environmental handbooks used for design and testing has been issued for the design of cold weather test environments at Army test sites. Performance data have been assembled to evaluate and improve the design of intrusion sensors. Laboratory tests and field trials were conducted on foundations, quick curing of low temperature concrete, utility distribution systems and pavements. This research was translated into construction criteria with the issuance of Technical Manual (TM) 5-852-4 "Arctic and Subarctic Construction, Foundations for Structures", preparation of TM 5-852-7 "Subsurface Drainage Design for Airfields and Heliports in Arctic and Subarctic Regions",



Program Element: #6.27.30.A

DoD Mission Area: #153 - Military Engineering Technology Base

Title: Cold Regions Engineering Technology  
Budget Activity: #1 - Technology Base

TM 5-818-1, Chapter 18 "Design of Foundations in Areas of Significant Frost-Penetration". Soil and permafrost investigations were conducted along the Trans-Alaska pipeline road to validate existing design data on initial conditions of foundations, slopes, roads and airfields obtained from previous research. Initial observations were taken along the pipeline route to establish a base for long term performance surveys of thaw-consolidation and settlement of fillings. Resistivity surveys made in Alaska demonstrated the use of the technology to locate permafrost, identify soil type and bedrock, with particular emphasis on grounding and cathodic protection potential. A methodology using infrared equipment to detect moisture contaminated insulation in roof replacement was required to correct moisture contamination problems. In each instance the team was successful in isolating the localized damaged areas with substantial savings resulting; for example, at Ft. Eustis, VA, \$165,000 was saved on one roof alone. FY 78: In-house \$2.551M, contractual \$0.359M.

2. FY 1979 Program: A troop test is being conducted this winter with the 172nd Brigade in Alaska to demonstrate the effectiveness of snow fortifications against Soviet weapons. The feasibility of applying electromagnetic energy to helicopter rotor blades to control icing is being assessed. Environmental data is being tabulated so that designers of major weapon systems can assess the risk versus cost of designing to specific performance levels in any environment. Methods are being developed for detection systems to describe the interaction between electro-magnetic radiation and natural terrain materials in support of battlefield obscuration research, including cold regions. A freeze/thaw pavement design model is being tested. The model can be used by the public sector as well as by Army engineers to construct roads that will be much less susceptible to frost damage. The potential of using microwave and magnetic induction to locate underground leaks in utility lines is being explored. FY 79: In-house \$2.732M, contractual \$0.340M.

3. FY 1980 Program: There are four planned major research activities in FY 1980; two are new starts, and two are a re-focusing of on-going research. The first new start addresses the concern expressed by the Under Secretary of the Army and the Vice Chief of Staff that the Army is not fielding equipment that is sufficiently reliable under adverse but likely-to-be encountered battlefield conditions. Specifically the capability of weapons systems to operate effectively under conditions of dust, snow, blowing snow and winter fog, is uncertain. Research will be initiated to characterize the battlefield environment. The second start is to develop engineering techniques which can be employed by the combat engineer in winter battlefield to an advantage; i.e., techniques for using winter fog and snow as camouflage, frozen rivers as ice bridges, compacted snow as helipads and for creating ice jams as barriers. This program is currently under development with the U.S. Army Engineer Center and School to determine the most important current shortfalls in winter combat. The on-going going research efforts are focused on developing criteria which will drastically reduce the annual cost of repairing Army roads and paved areas due to frost damage and to develop improved techniques to rehabilitate Army buildings in winter areas where temperature zone criteria fail to provide cost-effective operations. Emphasis will also be placed on research to reduce Operations and Maintenance (OM) cost of Army facilities. FY 80: In-house \$3.31M, contractual \$0.367M. Number of civilian personnel supported with requested FY 80 funds: Professional 40; Support 47.

Program Element: #6.27.30.A  
DoD Mission Area: #153 - Military Engineering Technology

Title: Cold Regions Engineering Technology  
Budget Activity: #1 - Technology Base

4. FY 1981 Program: The FY 80 program will be continued. Emphasis will be given to those areas showing immediate promise for transfer to Army using agencies. Efforts will be concentrated especially on "dirty battlefield" problems - the impact of natural and man-made environmental conditions on the operating effectiveness of Army weapons systems.

5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: # 6.27.31.A Title: Military Facilities Engineering Technology  
DoD Mission Area: #153 - Military Engineering Technology Base Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
AT41	Military Facilities Engineering Technology	2000	3000	3000	3759	Continuing	Not Applicable
<b>TOTAL FOR PROGRAM ELEMENT</b>		<b>2000</b>	<b>3000</b>	<b>3000</b>	<b>3759</b>	<b>Continuing</b>	<b>Not Applicable</b>

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** This program element is essential to support the planning, design, construction and maintenance of Army facilities worldwide. Constrained personnel resources and spiralling inflation have a major impact on the \$1.9 billion annual program for construction and the \$1.8 billion annual program to operate and maintain Army installations worldwide. The objective of this program is to reduce costs and increase productivity in constructing and maintaining Army installations, and to provide better more cost effective facilities from the standpoint of both initial and life cycle costs and reduce the logistic tail and skill level required for troop construction of facilities in the theater of operations. This will result in increased availability of resources for the Army's combat mission. It provides a base for identifying and adapting technologies to the special requirements of Army installations and achieving affordability and early return to investment. Major benefits are shortening of the planning and review cycle required to initiate new construction, compliance with criteria and effectiveness of Architect-Engineer designs, improved construction techniques and design criteria, improved utility systems, and a reduced backlog of maintenance.

**C. BASIS FOR FY 1980 RDTE REQUEST:** This program provides for technology development of systems and techniques to reduce costs and increase productivity of Army personnel; provide new quality control and quality assurance procedures to reduce facility construction cost and time; and evaluate and adapt innovation instruction materials and techniques to military construction and repair procedures. The program will specifically address industrialized building systems, roof maintenance and repair techniques and corrosion control. Construction materials and methods will be developed to emphasize rapid construction with a minimum of skilled troop labor in a theater of operations.



Program Element: #6.27.31.A Title: Military Facilities Engineering Technology  
DoD Mission Area: #153 - Military Engineering Technology Base Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
	2000	3500	4000	Continuing	Not Applicable

FY 1979 funding reduced by \$500 by Joint Appropriations Committee action in 95th Congress. FY 1980 funding reduced by \$1,000 as a result of higher priority Army requirements.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.31.A

DoD Mission Area: #153 - Military Engineering Technology Base

Title: Military Facilities Engineering Technology

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The objectives of this area project are: (1) to maximize the productivity of Army resources required to masterplan, design, construct, operate and maintain facilities in permanent installations in support of the Army mission in training and readiness; (2) to maximize the responsiveness of facility designs to Army mission requirements and minimize the life cycle costs of the facilities; and (3) to develop facility designs for troop construction which require less time and fewer less skilled troops. The research is being directed toward four major thrust areas: (1) to develop automated systems which will provide Army personnel in all stages of military construction with tools and techniques to maximize the productivity and quality of military construction at the least cost, (2) to develop systems which will maximize effectiveness in resource allocation to operate, maintain and repair existing military facilities, (3) to develop and evaluate alternatives to expensive construction materials, construction systems, construction control and repair and maintenance techniques used in facility construction and operations; and (4) to develop material systems and construction techniques for rapid construction in a theater of operations.

G. RELATED ACTIVITIES: This program is coordinated service-wide through the Joint Service Civil Engineering Research and Development Coordinating Group, The Tri-Service Committee on Protective Coatings and The Integrated Facilities System Project Advisory Group. Coordination with intergovernmental agencies is accomplished through the Joint Services Building Materials Program with the National Bureau of Standards, Modular Integrated Utility Systems with the Department of Housing and Urban Development and participation in the National Academy of Sciences Building Research Advisory Board. Related programs include: Project AT23, Basic Research in Military Construction, Army Engineer Construction Engineering Research Laboratory, Champaign, IL; Project AT40, Mobility and Weapons Effects, Army Engineer Waterways Experiment Station, Vicksburg, MS; Project AB96, Environmental Quality Technology, Army Engineer Construction Engineering Research Laboratory, Champaign, IL.

H. WORK PERFORMED BY: Approximately 65% of the project funds are used for in-house effort at the Army Engineer Construction Engineering Research Laboratory. Proposed major contractors for FY 1980 include: Carnegie-Mellon Institute, Pittsburgh, PA; Daniel, Mann, Johnson and Mendenhall, Los Angeles, CA; the University of Illinois, Urbana, IL; and the Massachusetts Institute of Technology, Cambridge, MA.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAM:

1. FY 1978 and Prior Accomplishments: To improve the military facilities design and construction process, accomplishments include the completion of: (1) a computer-aided system for the preparation of construction specifications; (2) design field tests of an automated cost estimating system to reduce the time and increase the accuracy of final design cost estimates; (3) field testing of a system to review architectural designs for conformance with criteria; (4) a system to evaluate and analyze capacities of existing and new utility systems to meet requirements of facility changes or planned new construction, (5) the development of contract procedures for use of industrialized buildings in military construction; and (6) field testing of a prototype system to generate and validate functional requirements for new planned facilities to eliminate over-design and increase effectiveness, (7) Development of a system to monitor weld quality during the weld placement operation, (8) the Kelley Vail test for concrete strength before it hardens, (9) field surveys of five major installations to identify corrosion problems associated with design or construction practice, (10) a seismic design guide for assuring survival of critical facilities. Accomplishments to increase

Program Element. #6.27.31.A  
DoD Mission Area: #153

Military Engineering Technology Base

Title: Military Facilities Engineering Technology  
Budget Activity: #1 Technology Base

productivity in the operation and maintenance of military facilities include: (1) a computer program to interface the Pavement Maintenance Management System with the Army Integrated Facilities System (IFS); (2) a Facility Engineer Equipment and Maintenance System to better manage and schedule maintenance and repair activities on utility systems; and (3) functional layouts for 12 types of facility maintenance shops to improve effectiveness and modernize facilities. Accomplishment to develop rapid and mission oriented construction in the theater of operations included: (1) a draft field manual on polyurethane foam construction techniques to provide support for overhead cover in combat areas; (2) a feasibility study to demonstrate the use of fiber reinforced concrete applied pneumatically to produce hardened fighting positions. Research activities to develop and adapt technology to meet the President's energy goals included: (1) the development of an automated fixed facility energy profile metering and analysis system; (2) standards for determining feasibility of waste derived fuel; (3) a methodology to determine the feasibility of solar energy for heating and cooling of buildings; (4) standards for using solar panels to preheat make up water for boilers; (5) development and field validation of the Building Loads Analysis and System Thermodynamics (BLAST) to evaluate energy consumption in buildings.

2. FY 1979 Program: Major research activities to improve the military construction process include: (1) development of a system to provide a building index and construction tasks for the computer-aided final design cost estimating system; (2) demonstration of prototype for a construction project data handling system as a module for the Computer-Aided Engineering and Architectural Design System (CAEDS); (3) prototype testing for a computer based construction contract specification system for use throughout the Corps of Engineers; (4) development of prototype procedures for systematically formulating habitability design criteria and pilot test the procedures for validation; (5) development of guidelines for seismic strengthening of critical military facilities in seismic zones 3 and 4 based on a model analysis procedure; and (6) improved quality control and quality assurance technology in roofing construction. Research activities to improve productivity in the operation and management of military facilities include: (1) development of an operational procedures manual on corrosion survey techniques; (2) a corrosion cost prediction model to permit military planners to determine effectiveness of primary corrosion control efforts; and (3) a technical manual on shop modernization and improved shop layouts to increase productivity and efficiency in facility engineer shops. Research to develop rapid construction techniques for the theater of operations include: (1) testing of structures using foam to form command, control and communication shelters in the theater of operations; (2) modifications to the computer based specifications system for Theater of Operations construction applications and prepare documentation to produce Army training material for use by the U.S. Army Engineer School and the U.S. Army Training and Doctrine Command. Research to develop and adapt technology to meet the President's energy goals include: (1) the preparation of an analysis and report of energy consumption; (2) performance tests on devices for reducing losses from flue stack gases; waste heat recovery from air conditioning, refrigeration equipment and kitchen exhaust hoods; (3) losses from insulation, air infiltration and leaks in steam and hot water lines; (4) initiation of an investigation of electrical consumption in troop housing; (5) evaluation of the performance of solar system components.

3. FY 1980 Planned Program: Planned program activities to improve the military construction process include: (1) field tests and prototype evaluation of the computer-aided cost estimating system and preparation of the system transfer to the user; (2) subsystem software development specifications for the Computer-Aided Engineering and Architectural Design System (CAEDS); (3)



Program Element: #6.27.31.A

DOD Mission Area: #153 Military Engineering Technology Base

Title: Military Facilities Engineering Technology  
Budget Activity: #1 - Technology Base

development of feedback methods to determine if a constructed facility is responsive to the mission requirements; (4) a technical manual on industrialized building systems to provide guidance on requests for proposals, product testing, design review, quality control and contract administration; (5) a technical manual on microprocessor applications to construction activities in Corps of Engineers field offices; (6) an automated system for predicting the strength of concrete in the plastic state; (7) design specifications for constructing a weld quality monitor; and (8) development of criteria for the use of plastics in corrosion control. Research activities to improve productivity in the operation and maintenance of military facilities include: (1) the development of a management system to support facility engineer management of family housing and bachelor housing; (2) development of specifications and installation guidance to use the most cost-effective materials for increasing the operational life of pavement systems; and (3) construction of test sites using selected now low-sloped roofing systems designed to increase performance and reduce maintenance and repair. Scheduled research for rapid construction in the theater of operations include recommendations on the use of foam materials for the construction of command, control and communication centers in the theater of operations. The research in FY 1980 will involve 38 professional and 18 support personnel for the in-house effort and monitoring the out-of-house contract effort.

4. FY 1981 Planned Program: Planned research thrusts to improve the military construction process include: (1) a computerized architectural evaluation system to evaluate architectural design for compliance with stated criteria; (2) development of procurement procedures to allow the Corps of Engineers to use industrialized building and systems building technology in the military construction process; (3) development of a data base management system of generating military construction design guidance; (4) design criteria for use of structural plastics in military construction. Research to increase the productivity in operation and management of military facilities includes (1) development of a preventive maintenance program and economic analysis and repair activities on built-up roofing systems and (2) a manual on corrosion control at Army facilities which will provide techniques to reduce the cost corrosion maintenance and repair. Research activities addressing rapid construction in the theater of operations include the development of a program to simulate the engineer troop activities in vertical construction missions in the theater of operations.

5. Program to Completion: This is a continuing program. Improvements to the military construction process will include research to address: (1) the design criteria for livability in Army facilities derived from functional requirements; (2) development of a model to evaluate the impacts of program fluctuations, interface changes and functional changes on the military construction process; (3) the Computer-Aided Engineering and Architectural Design System (CAEADS) - FY 1987. Research to improve productivity in operation and maintenance will include: (1) a maintenance management system for built-up roofing; (2) a computer-aided facility engineer system to improve the timelines and quality of resource allocation and planning; and (3) completion of the facility engineer housing information system to support management of family and bachelor housing at military installations. Accomplishments for rapid construction in the theater of operations include: (1) the development of a computer simulation program for engineer troop units involved in horizontal construction and barrier and defense operations which will model engineer efforts under different operating conditions and (2) recommendations to improve the effectiveness of real property maintenance in the theater of operations.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.32.A

DOD Mission Area: #124 - Target Exploitation

Title: Remotely Piloted Vehicles (RPV) Supporting Technology  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs	Not Applicable
<u>TOTAL FOR PROGRAM ELEMENT</u>								
AF 34	Remotely Piloted Vehicle Supporting Technology	1300	1100	2744	2899	Continuing	Not Applicable	

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The objective of this element is to develop technological capabilities in those areas which currently limit the operational potential of small RPV's for Army missions of Target Acquisition, Designation and Aerial Reconnaissance (TADAR), and for future missions. RPVs are required to extend the eyes of the Brigade and Division commanders to the range of their artillery, increase the effectiveness of their direct support firepower, and provide laser designation for laser guided weapons. Growth capabilities, cited in the engineering development specification for the TADAR mission, needing further development include multiple control and eyesafe lasers (for training). This project will define and develop those capabilities. Other activities include propulsion improvements, night and all-weather sensors, survivability/vulnerability and study of further missions, e.g., relay, decoy, and radac survey. These exploratory development efforts will enhance the mission effectiveness of small RPV's, improve system reliability, and reduce life cycle costs wherever possible.

C. BASIS FOR FY 1980 RDTE REQUEST: Funds requested provide for completion of the ground simulator for investigating multicontrol configurations, initiation of development and fabrication of low cost electro optics for a second generation RPV flight testing of a millimeter surveillance radar and survivability modeling. Each of these projects seek to improve mission effectiveness by developing growth capabilities for the Army's target acquisition and designation missions. Funding will also be provided for investigation of future mission configurations and for improved propulsion systems.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Cost	Not Applicable
Funds (as shown in FY 1979 submission)	1500	2375	3000	Continuing	Not Applicable	

Program Element: #6.27.32.A  
DoD Mission Area: #124 - Target Exploitation

Title: Remotely Piloted Vehicles (RPV) Supporting Technology  
Budget Activity: #1 - Technology Base

FY 1978 funds in the amount of \$200K have been reprogrammed for higher priority projects. Only \$1100K of the \$2375K requested for FY 1979 were appropriated. FY 1980 and FY 1981 plans have been restructured based on 1978 and 1979 actual funds.

E. OTHER APPROPRIATION FUNDS: Not Applicable



Program Element: 06.27.32.A

Sub Mission Area: 0124 - Target Exploitation

Title: Remotely Piloted Vehicles (RPV) Support Technology  
Budget Activity: 01 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The objective of the Army RPV program is to field mini-RPV systems which have high reliability and which are cost effective for selected missions. The first priority Army mission is Target Acquisition, Designation and Aerial Reconnaissance (TADAR). The first generation system will provide day mission capabilities via a fixed wing mini-RPV under command from a Ground Control Station (GCS). The Engineering Development Program is structured to accommodate growth, most notably a night mission capability (FLIR), multiple control and other modular payloads. Alternate missions are also being considered, including electronic warfare (both communication and non-communication jamming), relay, decoy, and radac survey. This exploratory development program addresses the growth capabilities for the TADAR mission, as well as the future mission configurations. Analysis, simulation, and limited testing is conducted so that subsystems/payloads essential to the complete RPV system can be selected and optimized. Five areas of investigation are being pursued: air mobility (survivability, propulsion, and launch/recovery), radar (millimeter), missions, command and control (multiple control, extended range, and out of line-of-sight), and electro-optics (low-cost FLIR's, lasers, and autotracker).

G. RELATED ACTIVITIES: Within the Army, Advanced Development is conducted under Program Element (PE) 6.37.25.A, Remotely Piloted Vehicles (RPV)/Drones, and Engineering Development of the first generation RPV will be conducted under PE 6.47.30.A, Remotely Piloted Vehicles. Another related effort is being started under PE 6.32.06, Mast Mounted Sight. This effort will use the RPV PE 6.37.39.F, Advanced RPV's, and PE 6.47.46.F, Expendable Drones, are being monitored. Quarterly Joint Technical Coordinating Group meetings are held to assure cooperation between the Services.

H. WORK PERFORMED BY: The Research and Technology Laboratories, Headquarters, Moffett Field, CA; and the Applied Technology Laboratory, Fort Eustis, VA; US Army Electronics Research and Development Command, Fort Monmouth, NJ; Night Vision and Electro-Optics Laboratory, Fort Belvoir, VA; the US Army Avionics Research and Development Activity, Fort Monmouth, NJ; and the US Army Human Engineering Laboratory, Aberdeen Proving Ground, MD. Contractors expected to participate are: Harris Corporation, Melbourne, FL; General Electric, Utica, NY; Texas Instruments, Dallas, TX; Hughes Aircraft, Culver City, CA; Honeywell, Minneapolis, MN; Ford Aerospace, Newport Beach, CA; Norden, Norwalk, CT; Motorola, Phoenix, AZ; North American Rockwell, Los Angeles, CA; Teledyne Continental, Mobile, AL; Aerotech Industries, Auburn, AL; Developmental Sciences, Incorporated, Industry, CA; RCA, Burlington, MA; and Santa Barbara Research Group, Santa Barbara, CA.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: This was a new PE in FY 1977 and the bulk of funding was directed toward the development, fabrication, and ground testing of an anti-lam data link, the Integrated Communication and Navigation System (ICNS). This system was subsequently integrated into two AQUILA RPV's and flight tested at Fort Huachuca, AZ, under PE 6.37.25.A. Two contracts were funded in FY 1977 for the development of two cylinder engines with nominal 20 HP output and a production cost goal of \$750. In-house analyses of visual and radar signatures of RPV's, as well as a study of manufacturing techniques for airframe, were completed in FY 1977. The Army Required Operational Capabilities (ROC) and Engineering Development Specification for the

Program Element: #6.27.12.A

Title: Remotely Piloted Vehicles (RPV) Supporting Technology

DoD Mission Area: #124 - Target Exploitation

Budget Activity: #1 - Technology Base

Target Acquisition, Designation, and Reconnaissance System (TADAKS) was issued in FY 1978 and it stated that multicontrol was a growth requirement for the data link and that the night vision capability (FLIR) was a growth consideration for mission payload. As such, in-house studies of multiple control options within the Ground Control Station (GCS) and antenna configuration were initiated in FY 1978. Two contracts were awarded in FY 1978 for the modification of a Honeywell POISE gimbal to include 8-12 micron FLIR's and ground testing. Subsequent flight testing of one of the systems was conducted under PE 6.37.25.A and target acquisition ranges exceed the Required Operational Capabilities (ROC). The contracts for engines (awarded in FY 1977) resulted in delivery of hardware to the Government in May/June 1978. Government testing for performance and endurance for these engines is nearing completion and was funded under PE 6.37.25.A. Modifications were completed on a 95 Gigahertz millimeter surveillance radar so that ground testing can be accomplished in FY 1979. A prototype 2.06 micron eyesafe laser rangefinder program was funded and has demonstrated greater than 2 km range performance against noncooperative targets. In addition to the foregoing, in FY 1978, automatic recovery investigations were conducted and a flight demonstration of one concept was funded, an alternate pneumatic launcher was ground tested, propellers optimized for performance were fabricated, and acoustic signature characteristics of propellers were statically and dynamically tested in an effort to reduce acoustic observables and thereby increase survivability.

2. FY 1979 Program: The primary program emphasis in FY 1979 is to define/develop those growth capabilities identified in the ROC and Engineering development (ED) specification, namely, the control of multiple RPV's from a single GCS complex, and development of eyesafe laser rangefinders suitable for training. Contractual efforts will be initiated to fabricate a ground control and data terminal simulator for investigation and tradeoffs of system and equipment parameters for multiple control operations. Refinements of the eyesafe laser transmitter, detectors, and materials will be undertaken in FY 1979. Ground based testing of the millimeter radar will be performed at a contractor and Government site. Data will be collected on moving and stationary military targets in clutter and, insofar as is possible, in adverse weather conditions. A method for improving propulsive efficiency through ducted propellers will also be demonstrated.

3. FY 1980 Planned Program: Fabrication of the ground control and data terminal simulator will be completed and evaluation of system and equipment configurations will commence. A jointly funded survivability program (with Program Element 6.37.25.A) will be initiated with the objective of developing a capability for assessing the survivability effects of RPV system configuration changes, threat system updates, and operational tactics. The flight test investigation of the millimeter radar system will be completed. A study of improved propulsion systems will be started. The eyesafe laser rangefinder system will complete refinements and testing. A second generation RPV FLIR program in cooperation with Night Vision Laboratory and DARPA efforts in focal plane array will be started in FY 1980. Investigation of future RPV mission configurations for the relay and decoy applications will be initiated. This program element supports the work of 11 civilian professional and support personnel.

4. FY 1981 Planned Program: The multiple control configuration tradeoff results will be documented in a report. The survivability modeling capability initiated in FY 1980 will be completed. The study of propulsion requirements will be completed and a contract will be awarded for development of an engine, if appropriate. Key components essential to the miniaturization of

Program Element: #6.27.32.A  
DoD Mission Area: #124 - Target Exploitation

Title: Remotely Piloted Vehicles (RPV) Supporting Technology  
Budget Activity: #1 - Technology Base

the millimeter radar (target weight of 40 pounds) will be fabricated. Future mission configurations for the decoy and radiac applications will be investigated. The second generation night vision capability (FLIR) effort with the Night Vision Laboratory will continue. Programs for development of intelligent autotrackers and bandwidth compression schemes, necessary for more autonomous RPV operations will be started.

5. Program to Completion: This is a continuing program.



FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6, 27, 33-A  
 DoD Mission Area: #154 - Mobility and Logistics Technology  
 Title: Mobility Equipment Technology  
 Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>9555</b>	<b>9714</b>	<b>9991</b>	<b>9885</b>	<b>Continuing</b>	<b>Not Applicable</b>
AH20-01	Fuels and Lubricants	2150	2458	2248	2225	Continuing	Not Applicable
AH20-02	Countermine and Barrier Techniques	4080	3776	4266	4220	Continuing	Not Applicable
AH20-03	Combat Support Technology	3325	3480	3477	3440	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The work under this program is exploratory development in the areas of fuels, lubricants, power transmission fluids and corrosion preventive coatings; mine detection and neutralization; advanced tactical barriers and related concepts; camouflage; power generation; bridging; water and wastewater management; environmental control; marine equipment; containerization; construction equipment; expedient surfacing and soil stabilization. Army mission need is reflected in the unavailability of: field fortifications and obstacles that effectively provide the ability to economize forces, exhaust an attacking enemy and provide adequate gain in time to prepare for offensive action; anti-vehicular barriers that require reduced logistical and support burdens; controllable barrier systems that efficiently impede enemy units but permit safe passage of friendly forces; tunnel detection means to recognize and classify seismic and acoustic activity associated with underground activities; highly competent means of stand-off detection of surface-laid mines; a family of mine neutralizers for use by air and ground vehicles and in a man-pack mode; sufficiently strong, advanced, light-weight mobile bridging structures for Class 60 bridges; highly efficient camouflage techniques for thermal decoys that provide low emissivity in the dark; expedient means for soil stabilization and surfacing; means for provision of rapid logistics-over-the-shore operations; high efficiency fuel cell catalysts and electrodes for silent power generation; economical and effective air conditioning capabilities for combat vehicles and shelters; means for providing low vulnerability fuels to help generate significant improvement in combat survivability; detailed understanding of effects of alternate fuels on combat vehicle operations and performance; adequate guidelines for reliable use of extended-interval oils and lubricants and re-refined oils; and highly reliable hydraulic fluids with improved fire resistance, low-temperature operational properties and potential for economical use.

C. BASIS FOR FY 1980 RDT&E REQUEST: Requested funds provide for the following: Investigation of improved air conditioning systems that provide chemical biological and radiological protection for armored combat vehicles; continued work on low cost fuel cells, improved power distribution, and new air conditioning concepts. Continue programs to improve close-in buried minefield detection and stand-off surface minefield detection, close-in neutralization of minefields via demagnetizing armored vehicles, stand-off neutralization of minefields by means of high energy explosives and remotely controlled vehicles, advanced barrier systems.

Program Element: #6.27.33.A

DoD Mission Area: #154 - Mobility and Logistics Technology

Title: Mobility Equipment Technology

Budget Activity: #1 - Technology Base

Investigate military effectiveness and perform systems analysis of field fortifications. A new major thrust will be initiated on high strength, lightweight composites for bridging structures. Continue development of improved methods for supply distribution, excavation, camouflage, explosive and minefield detection and neutralization. Develop and evaluate membranes and microstrainers for water supply with ability to remove trace turbidity. Evaluate water detection methods for desert environments. Evaluate coatings and adhesives for Kevlar seamless water supply tanks. Develop criteria for closed circuit automatic refueling of combat vehicles. Continue major problems to develop and evaluate improved multi-purpose anti-freeze, high performance engine oils, high-energy fuels, and nonflammable hydraulic fluid. Accelerate and expand programs to develop means to modify ground combat vehicle fuels to satisfy urgent need for improved fire survivability.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
ROUTE					
Funds (as shown in FY 1979 submission)	9555	10208	9991	Continuing	Not Applicable

The decrease in FY 1979 is due to adjustments to provide funding for higher priority requirements.

E. OTHER APPROPRIATIONS FUNDS: Not Applicable.

Program Element: #6.27.33.A

DOB Mission Area: #154 - Mobility and Logistics Technology

Title: Mobility Equipment Technology

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: This program covers those efforts directed towards overcoming all conceivable obstacles to mobility, whether the obstacles are enemy created, naturally created, or are a result of our own logistics shortcomings. Currently, this program explores systems for the physical security of our forces and support activities by the use of new and advanced camouflage techniques and new barriers and intruder detection devices. It covers exploratory development work to detect and neutralize minefields and new and improved marine and bridging capabilities to by-pass minefields and/or to cross water and land gap obstacles. New and improved mobile electric power sources and distribution means are explored. It covers work to determine whether or not Army diesel engines can operate satisfactorily on non-specification fuels, e.g., those with a high sulfur content which are common in many parts of the world. At the same time, new formulations are tested to significantly decrease the fire hazard of fuels, lubricants and hydraulic fluids used in our combat and tactical vehicles. Finally, it covers water purification systems, containerized, bulk cargo and fuel handling equipment, logistics watercraft, environmental control, and rapid construction materials and means, to provide the support needed to sustain Army mobility and logistics in an hostile environment.

G. RELATED ACTIVITIES: In the fuels and lubricants technical area, active liaison and coordination is maintained with other Services, the Environmental Protection Agency, Federal Aviation Administration, and Department of Energy. The Countermine and Barrier Technical Area provided direct support for advanced and engineering development program elements 6.36.06.A, Landmine Warfare; 6.36.19.A, Countermine and Barriers; 6.46.19.A, Landmine Warfare; and 6.46.12.A, Countermine and Barriers. Combat Support Technology areas interface with other Services and agencies through the Interagency Advanced Power Group, Logistics Systems Policy Committee, Joint Container Steering Group, and Program Manager for Army Container-Oriented Distribution System.

H. WORKED PERFORMED BY: In-house work by US Mobility Equipment Research and Development Command, Fort Belvoir, VA; US Army Engineer Waterways Experiment Station, Vicksburg, MS; Yuma Proving Grounds, Yuma, AZ; US Army Armament Research and Development Command, Aberdeen, MD; and Harry Diamond Laboratories, Washington, DC. Contractual support is provided to Southwest Research Institute, San Antonio, TX; SKF Industries, Philadelphia, PA; Yucca MI; International, Incorporated Scottsdale, AZ; Energy Research Corporation, Danbury, CT; Chrysler Corporation, Detroit, MI; Goodyear Aerospace, Akron, OH; and Backman Industries, Carlsbad, CA. Contracts are planned amounting to \$4.5 million.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Established operating conditions for improved organic electrolyte fuel cells. Hybrid power source has been developed and tested to load profiles of electric forklift trucks. Developed silicon carbide fuel cell matrices for increased reaction rate and carbon monoxide tolerance. Continued analysis and tests on improved air cycle and absorption cycle air conditioning systems. Completed compressor-expander tests of air cycle environmental control unit for mobile applications. Investigated rock mechanics and underground construction for military shelter. Evaluated foreign entrenching machines. Completed cost and operational effectiveness analysis of an air cushion barge 120-150 ton for logistics over the shore operations. Fabricated prototype sandbagger capable of producing 600 bags/hr using a 4-man crew. Surveyed industry for state-



Program Element: #6.27.33.A

DoD Mission Area: #154 - Mobility and Logistics Technology

Title: Mobility Equipment Technology

Budget Activity: #1 - Technology Base

of-the-art visibility/safety devices for materials handling equipment. Developed bridging concepts, materials and methods for the 1980's. Continued programs on smoke, foam, camouflage, and other methods for reduction of thermal and radar signatures. Evaluated multidisciplinary approaches to long-range detection of remote minefields. Continued evaluation of an off-route buried minefield detector, a man-portable metal radiation detector, and explosive detectors. Defined mass, velocity, size of selected materials to penetrate soil cover and mine casing to detonate the secondary explosive in land mines. Demonstrated the feasibility of spraying fuel-air explosives (FAE) from a flame-throwing tank. Demonstrated the use of ground-vehicle mounted systems for mine neutralization. Completed systems analysis study of track and suspension system vulnerabilities for developing barrier entangling devices. Conducted laboratory and field tests to improve persistence of foam barriers to weather effects. Continued efforts on improving engine oils and lubricants, issued specification for helicopter spline grease and evaluated long-life automotive/artillery grease. Developed improved antifreeze corrosion inhibitors and extenders. Evaluated candidate fire-safe fuels and established an optimized formulation to be further tested. Completed study of chlorine-resistant sea water membrane for water purification.

2. FY 1979 Program: Continue effort on simplification, cooling, and modularization of power conditioners. Define distribution system components. Initiate efforts in managing DARCOM Energy R&D. Complete performance optimization of improved fuel cell anodes. Develop components for advanced acid electrolyte fuel cells. Assemble and check hybrid power source components. Initiate exploratory development of second generation absorption cycle air conditioner and combat vehicle environmental support system. Continue work on selected minefield sensors such as multispectral photography and electromagnetic techniques. Continue program on short pulse radar and portable detectors. Accelerate work on sprayed fuel-air explosives and vehicle demagnetization. Continue program on tractive entanglement devices for barriers. Investigate new and improved bridging materials for advanced bridge types. Continue work on multispectral coatings, and thermal and radar signatures, for camouflage. Prepare concept formulations for air cushion barge. Evaluate improved high-speed excavation equipment. Continue evaluating tunnel detection techniques.

3. FY 1980 Planned Program: Explore feasibility of use of graphite intercalation compounds for electric cables. Develop components for advanced fuel cell. Continue efforts on stand-off buried minefield detection and portable mine detectors. Increase level of effort on vehicle component hardening and demagnetization. Continue efforts on tractive entanglement barriers. Complete visibility/safety device evaluation, test of vibratory dozer blade mechanism, and test of high pressure exhaust gas explosive kit to air excavation. Continue concept manuals development for bridging. Continue smoke, foam and multispectral coating work. Test air cushion barge. Continue determinations of wastewater reuses and ground water detection and purification. Continue exploratory development work of fuel storage tank materials, rapid deployment, and closed circuit refueling. Continue performance evaluation of oil compounded from re-refined base stocks, and high sulfur fuels. Evaluate power transmission fluids; test fire-safe fuel filter/decontaminators and high energy fuel filter/decontaminators. Accelerate and expand program on high strength, lightweight composite bridging components. There will be 125 professional and 175 support personnel involved in these efforts.

Program Element: #6.27.33.A

DoD Mission Area: #154 - Mobility and Logistics Technology

Title: Mobility Equipment Technology

Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: Explore modular components for power transmission and distribution, including cables based on previous years' insulation work. Initiate contract to build large capacity generator to power experimental beam devices. Electrode structures incorporating non-noble metal catalysts will be optimized for advanced acid electrolyte fuel cells. Combine sensor effectiveness models and military worth models to develop program for remote minefield detection and continue efforts on portable mine detectors. Continue efforts on defining techniques of armored vehicles to defeat magnetic influenced mines. Initiate investigations of advanced high energy nonlethal interactive barrier elements. Continue to evaluate excavating aids such as fluid jets and explosive kit which use high pressure exhaust gases. Continue to evaluate materials/techniques for future bridging. Expand on coatings and techniques to camouflage multispectral signatures. Further evaluate air cushion barge. Continue investigations of bulk fuel storage container materials. Initiate concept of lubricated-for-life, zero-maintenance bearings for Army combat vehicles; continue development of aircraft gear greases and antifreeze extenders. Determine effects of fire-safe fuel on power, range, performance and RAM-D characteristics. Conduct evaluation tests, and develop specifications for high energy fuel, synthetic fuels and synthetic oils for Army vehicles, and complete specification for finished re-refined oil. There will be 122 professional and 171 support personnel involved in these efforts.

5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.34.A

Title: Medical Defense Against Chemical Agents  
DoD Mission Area: #135 - Chemical Biological Warfare  
Technology Base

Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
<u>TOTAL FOR PROGRAM ELEMENT</u>							
AM26	Medical Defense Against Chemical Agents	6448	7027	5796	5846	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Death, disability and significant decrements in combat performance will result from hostile uses of a wide variety of chemical warfare (CW) agents. Effective medical defenses are critical to insure the survival and combat effectiveness of troops engaged with hostile forces employing CW agents. Research is urgently needed to develop improved chemoprophylactic protective measures and chemotherapeutics, particularly for exposures to high concentrations of CW agents, and to develop improved methods and materials for skin decontamination. Research focus must be on the full range of health effects of exposure to CW agents, chemoprophylactics and chemotherapeutics.

C. BASIS FOR FY 1980 RDTE REQUEST: TAB (TMB-4, atropine, and benactyzine) antidote mixture can prevent death in experimental animals challenged with lethal doses of chemical agents, but does so at the cost of marked incapacitation. Extent of incapacitation will be defined and projections made on how this influences use in terms of dose size and frequency. Replacement drugs will be under development. Chemical casualty decontamination will also be addressed. Studies will continue to develop protective skin coating and personal decontaminants. Pyridostigmine will continue to be evaluated as a prophylactic medication.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
	6448	6027	5639	Continuing	Not Applicable

Basis for change: FY 1979 and FY 1980 increases due to increase in priority for research in medical defense against chemical agents.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.27.34.A

DoD Mission Area: #135 - Chemical Biological Warfare  
Technology Base

Title: Medical Defense Against Chemical Agents  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: Analysis indicates that hostile forces are tactically and philosophically prepared to employ a wide variety of highly lethal chemical warfare (CW) agents against US troops. These forces have sizable stockpiles of CW agents; varied and sophisticated means of delivery; and a training, organization and tactical doctrine that lead analysts to conclude that CW munitions are regarded as "conventional" and would be employed against US troops according to the tactical situation. Individual protective measures available to US troops are limited, often of questionable effectiveness, and frequency degrade combat effectiveness. Identification and effective medical treatment of CW casualties are constrained by lack of knowledge of early signs and symptoms of CW exposure and limited treatment modalities available to prevent death or serious disability. This program is designed to develop safe and effective individual protection against CW agents and will: (1) develop prophylactic drugs for potential long-term use by troops operating in a potential CW combat environment; (2) develop drugs to treat CW casualties; (3) develop skin decontamination and other protective methods and materials; and (4) develop appropriate physiological and psychological tests to measure health effects and decrements in combat performance in humans as a consequence of exposure to CW agents, chemoprophylactic agents, and therapeutic drugs.

G. RELATED ACTIVITIES: Program Element 6.27.80.A, Medical Systems in Chemical Defense, focuses on collective rather than individual prevention and therapy. All work is coordinated with quadripartite nations, Air Force, and Navy. Investigation of performance decrements from the TAB (TMB-4, atropine, and benactyzine) antidote mixture using flight simulators is a joint effort with scientists at Brooks Air Force Base, TX.

H. WORK PERFORMED BY: Principal in-house research is performed by the Biomedical Laboratory of the Chemical Systems Laboratory, Aberdeen Proving Ground, MD. In-house research is also performed by Walter Reed Army Institute of Research, Washington, DC; US Army Medical Research Institute of Infectious Diseases, Ft Detrick, Frederick, MD; US Army Research Institute for the Behavioral and Social Sciences, Arlington, VA; and Army Natick Research and Development Command, Natick, MA. Extramural research is performed by the Johns Hopkins University, Stanford Research Institute, Ash Stevens, University of Kansas, and US Air Force.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Previous research efforts, in-house and extramural, have: (1) identified pyridostigmine as a potentially safe and effective prophylactic agent against organophosphate (nerve gas) poisoning; (2) identified TAB as being therapeutically more efficacious than atropine alone (first generation drug treatment) in reversing the lethal effects of organophosphate poisoning in animals; (3) initiated investigation in animals of the side effects associated with TAB administration (particularly in the absence of an organophosphate challenge); (4) initiated an IND (Investigational New Drug) submission to the Food and Drug Administration (FDA) necessary for eventual human trials to investigate tolerance limits and associated decrements in soldier performance associated with TAB; (5) defined a suitable animal model to test new therapies for mustard induced lesions; (6) secured conditional FDA approval to conduct trials in human volunteers of the decrements in visual dynamics associated with benactyzine (one of the three chemical constituents of TAB); and (7) started developing field assay methods.

Program Element: #6.27.34.A

DoD Mission Area: #135 - Chemical Biological Warfare  
Technology Base

Title: Medical Defense Against Chemical Agents  
Budget Activity: #1 - Technology Base

2. FY 1979 Program: Program goals include: (1) continue evaluation of pyridostigmine as the primary prophylactic agent; (2) screen other available chemicals as potential prophylactic candidates; (3) continue evaluation of the side effects of TAB (TMB-4, atropine and benactyzine) in animals; (4) initiate human studies to determine the effects of benactyzine on the visual system in a continuing effort to ascertain the broad range of central nervous system (CNS) effects of TAB; (5) continue development and evaluation of more effective skin decontamination techniques, assays, and materials; (6) screen chemical compounds that may have potential as new chemotherapeutics for treating chemical warfare (CW) casualties.
3. FY 1980 Planned Program: Continue focus on broad objective of developing effective prophylactic, treatment, and decontamination methods. Emphasize development of candidate chemical replacements for TAB and/or pyridostigmine with principal focus on identifying drugs with increased safety and efficacy. Initiate animal model safety and efficacy studies of candidate compounds. Continue development of skin decontamination techniques, assays, and materials. Continue evaluation of CW health effects in animal models with focus on thickened agents. Approximately 185 personnel will be utilized for this program; professional 134, support 51.
4. FY 1981 Planned Program: Complete initial animal model safety and efficacy studies of candidate chemical replacements for pyridostigmine and TAB. Develop protocols for human testing and initiate IND (Investigational New Drug) for candidate prophylactic and therapeutic compounds as required by the Food and Drug Administration (FDA) regulations. Apply skin decontamination technology to thickened agent exposures.
5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.70.A  
 DoD Mission Area: #131 - Medicine and Life Sciences  
 Title: Military Infectious Disease Technology  
 Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ In thousands)

Project Number	Title	TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
A802	Military Preventive Medicine and Tropical Diseases		6651	7820	8212	7654	Continuing	Not Applicable
A803	Drug Development		8377	7334	4000	4200	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Historically, infectious diseases have caused the land combat commander more casualties than overt enemy activity. Objectives of the program are to conduct studies of parasitic, bacterial, rickettsial, and viral diseases of military importance. Research efforts include investigations in epidemiology, control, prevention, treatment, and evaluation of disease impact on military operations. Methods for laboratory investigations are explored, developed, improved, and standardized.

C. BASIS FOR FY 1980 RDT&E REQUEST: Research will concentrate on specific infectious diseases which have the greatest proven or potential impact on troops in training, mobilization, or combat operations. Efforts will concentrate on developing data on diseases, reservoirs, vectors, development of new or improved vaccines and drugs for treatment, or for prevention of infection. Specific diseases of military importance to be studied are malaria, leishmaniasis, schistosomiasis, diarrhea, trypanosomiasis, scrub typhus, adeno- and arbovirus infections. New field and laboratory techniques for disease vector control will be developed and evaluated.



Program Element: #6.27.70.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Infectious Disease Technology

Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 80 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
RDTE					
Funds (as shown in FY 1979 submission)	15030	15154	15250	Continuing	Not Applicable

Basis for change: Decrease in FY80 is a result of de-emphasis on synthesis of new anti-malarial drugs.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.70.A  
DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Infectious Disease Technology  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: This program supports development of technology for assessment, diagnosis, prevention and treatment of infectious disease to minimize impact on training and mobilization of military operations worldwide. Epidemic and geographically unique endemic infectious diseases are a major constraint upon military strategic mobility. Includes studies required to investigate parasitic, bacterial, rickettsial, and viral diseases. Epidemiologic data provide information on the transmission, ecology, control, vectors, and reservoirs of militarily significant infectious disease. A major effort is devoted to development of improved methods for preventing, curing, and eradicating malaria as a menace to deployed military forces. Program derives from militarily unique impact of specific diseases which are not of general concern to the US civilian medical community. Forms the technological basis for formulation, advanced development, production, and testing of drugs, vaccines, and other biological means of protection against militarily important infectious diseases. Program is national resource; develops therapeutic agents against diseases affecting strategic mobility for which there is no domestic market.

G. RELATED ACTIVITIES: Related Army studies are performed under Program Elements/DA Projects 6.11.02.A/BS01, Basic Research on Military Injury and Diseases; 6.11.02.A/SB03, Medical Defense Against Biological Agents; 6.27.76.A/A841, Medical Defense Against Biological Agents; and 6.37.50.A/A808, Drug and Vaccine Development. Complementary infectious disease research conducted by the Navy, National Institutes of Health, Department of Agriculture, and the Center for Disease Control is pertinent to this program. The unique aspects of land combat operations dictate an Army program which focuses on optimal support of military operations and learning to recognize, prevent, and treat infectious diseases which cause more lost duty-time than combat wounds. Army representation on Department of Defense coordinating committee and other intergovernmental agency coordination councils insures coordination at the working and administrative levels in order to prevent duplication of effort. Army scientists serve as consultants with the World Health Organization and have access to this organization's studies, reports, and publications. Other coordination is accomplished by personal contacts at the operating level, by site visits by projects officers, organization of technical symposia on selected topics, routine exchange of reports among staff and laboratory organizations' open publication of results in scientific journals, and distribution of research and technology resumes.

H. WORK PERFORMED BY: Approximately 47% of the research is performed by in-house laboratories at Walter Reed Army Institute of Research, Washington, DC, and field units in Thailand, Malaysia, Brazil, and Kenya. Approximately 53% of the research is conducted under contract with universities, nonprofit organizations, and industry. The five major contracts are those with Herner and Co., Washington, DC; Midwest Research Institute, Kansas City, MO; Ash Stevens, Inc., Detroit, MI; Stark Associates, Buffalo, NY; and University of Miami, Miami, FL. Seventy-one other contracts are also funded in the amount of \$6,670,380.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Completed development and initial production of two meningococcal polysaccharide vaccines (Groups A and C). Developed adenovirus vaccine against types 4 and 7 adenovirus diseases; markedly reduced the incidence and morbidity of adenovirus infections in recruit centers. Identified adenovirus type 21 as a possible emerging

Program Element: #6.27.70.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Infectious Disease Technology

Budget Activity: #1 - Technology Base

strain of adenovirus. Completed alternative methods of isolation and serological tests of adenoviruses to assure effective vaccine development. Tested first production lot of Dengue 2 vaccine for safety and efficacy in lower primates and prepared an Investigational New Drug Application (IND) for human trials. More fully characterized and developed a promising vaccine against Dengue type 3. A new radioimmunoassay for hepatitis B identification in serum increased the specificity for detection of this virus. Characterized, and antisera prepared for, strains of swine influenza in military personnel. Studied arthropod-borne diseases in tropical and subtropical areas; data established on the vectors of malaria, arbovirus diseases, and filariasis in Southeast Asia. Identified diarrhea-causing properties of *E. coli* and *Salmonella* bacteria. Evaluated immune response of diarrhea-causing bacteria for developmental mechanisms for prevention and control of this disease in soldiers. Catalog of world mosquitoes published. Published identification key to malaria vectors for use by military disease control teams. Proved the feasibility of malaria vector control by the sterile-male mosquito control technique. Established laboratory colony of tsetse flies for use in evaluating potential vaccines against African trypanosomiasis. Conducted studies to determine the actual infection rate of leishmaniasis among soldiers operating in an endemic disease area during jungle warfare training. Determine effective dosages of four candidate insect repellents by bioassay on human skin against vector of leishmaniasis. Explored a new liposome drug delivery system for use in treatment of leishmaniasis. Established a new capability for pharmacokinetic analysis of new drugs in volunteers. Completed human study of mefloquine antimalarial prophylaxis which demonstrated nearly completed protection when administered weekly or bi-weekly. Determined single oral dose of doxycycline effective as a seven-day course of tetracycline in treating scrub typhus.

2. FY 1979 Program: Continue integrated research for improved drug prophylaxis and therapy of militarily important parasitic diseases. Continue development and evaluation of liposome delivery system for antileishmanial drugs. Evaluate additional drugs for prevention or treatment of leishmaniasis using developed animal testing system. Publish an identification manual of the vectors of leishmaniasis for use by vector control personnel. Develop procedures and animal models to evaluate prophylactic and therapeutic drugs against trypanosomiasis. Conduct preclinical studies of a new class of drugs showing a very high curative activity for malaria. Promising drugs evaluated in clinical and field trials against malaria will be submitted for Food and Drug Administration approval. Test new therapeutic systems in animals for efficacy in treating exotic endemic diseases. Evaluate new drugs in animals for therapeutic activity against infectious viral diseases. Conduct evaluations on a vaccine against dysentery. Evaluate a new control method for mosquito vectors in field tests; this method has potential in integrated pest management programs with a reduced decrement of the environment. Evaluate wild rodent, chigger, and human scrub typhus strains so necessary data can be obtained for use in early developmental studies of a vaccine. Continue development of a mosquito-virus model for determining the mechanisms involved in the overwintering of pathogenic arboviruses. Prepare identification manuals for arthropod vectors of pathogens of military importance. Develop effective procedures for diagnoses of infectious diseases which adversely affect troop operations and mobilization. Conduct epidemiological evaluations of military disease threats against which prophylactic and/or therapeutic efforts are being developed.

3. FY 1980 Planned Program: Complete development and testing of mefloquine, a prophylactic drug for malaria, and prepare a report. Evaluate, using animal models, drugs developed in the antimalarial program having antiparasitic activity for prophylaxis against other diseases causing soldier ineffectiveness or death. Terminate antimalarial drug synthesis; redirect synthesis efforts



Program Element: #6.27.70.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Infectious Disease Technology

Budget Activity: #1 - Technology Base

to higher priority targets. Complete development of a diagnostic procedure for early detection of leishmaniasis in troops operating in endemic areas. Complete laboratory development for a potential vaccine against African trypanosomiasis. Complete studies on an effective antischistosomiasis drug. Complete taxonomic aids for use in identification of mosquito vectors of arboviruses occurring in the Middle East and Amazon region. Determine vector-pathogen-host relationships for scrub typhus. Prepare technical data package for new insect vector surveillance light trap used by preventive medicine field teams. Develop and test a toxicant for impregnation into the military field uniform for protection of the soldier against blood-feeding insects and arthropod vectors of disease. Complete Investigational New Drug (IND) reports and submit to Food and Drug Administration on Dengue vaccines. Initiate preclinical trials for scrub typhus vaccine, clinical trials of infectious diarrhea vaccine. Continue studies to be directed toward development and evaluation of data and products which can be used effectively in control strategies of infectious diseases. Personnel to be utilized--260 professional, 125 support.

4. FY 1981 Planned Program: Apply previously developed antimalarial drug test systems to other parasitic diseases. Seek final FDA approval for efficacious antimalarial drugs. Begin clinical test of antitrypanosomal and antileishmanial drugs. Develop and test in laboratory bioassay two to four candidate prophylactic drugs for effectiveness in preventing schistosomiasis. Candidate African trypanosomiasis vaccine will be tested for efficacy and safety in primates and required data will be collected for evaluation in humans. Tests required for rapid diagnosis of leishmaniasis ready for fielding. Expand programs in insect/parasite repellents. Evaluate a pesticide-impregnated fatigue uniform under natural insect and environmental conditions for efficacy in preventing insect-borne diseases. Define epidemiology of pathogens causing tropical diseases in strategic geographical regions and determine the bionomics and transmission cycles of their vectors. Publish descriptive manuals to mosquito vectors in selected areas of Africa. Assess bacterial disease risks to soldiers conducting field operations in endemic areas. Complete primary prophylactic studies in volunteers for Dengue vaccines. Infectious diarrhea vaccine and scrub typhus vaccine ready for preclinical trial.

5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: A802

Program Element: #6.27.70.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Preventive Medicine

Title: Military Infectious Disease Technology

Budget Activity: #1 - Technology Base

A. DETAILED BACKGROUND AND DESCRIPTION: Infectious diseases are a threat to military operations and have been the major cause of manpower loss in all wars. Every element of the combat force is affected. The capability of strategic mobility is required to support national interests and is enhanced by an ability to cope with diseases peculiar to any geographic area. Research efforts must begin well before troop mobilization or deployment as years are often required to develop safe and effective preventive or therapeutic regimens for any disease. Program addresses broad range of infectious diseases with known or potential operational importance. Studies conducted in the laboratory and among troop populations in the field aim at improved assessment, prevention, and treatment. Special emphasis is given to diseases with impact on strategic mobility (worldwide deployment and early phases of combat). Secondary emphasis is on diseases which impede mobilization and training, critical for readiness for short and protracted wars. The research supports broad and continuing military field and laboratory-oriented programs essential to the control of infectious diseases of military significance.

B. RELATED ACTIVITIES: Performed under program elements/DA projects 6.11.02.A/BS01, Basic Research on Military Injury and Diseases; 6.27.76.A/A841, Medical Defense Against Biological Agents; and 6.27.70.A/A803, Drug Development. Complementary research conducted by the Navy, Department of Agriculture, National Institutes of Health, and the Center for Disease Control is pertinent to this project. Army representation on Department of Defense committees and other intergovernmental agencies (e.g., Armed Forces Pest Control Board and Armed Forces Epidemiological Board) insure coordination at the working and administrative levels to prevent duplication of effort. Army scientists serve as consultants with the World Health Organization and the Center for Disease Control and have access to these organizations' studies, reports, topics, routine exchange of reports among staff and laboratory organizations, open publication of results in scientific journals, and distribution of research and technology resumes.

C. WORK PERFORMED BY: Approximately 54% of the work is conducted in-house by the Walter Reed Army Institute of Research and overseas special foreign activities of the Walter Reed Army Institute of Research in Thailand, Brazil, Malaysia, and Kenya. About 46% of the effort is performed by universities, nonprofit organizations, and industry. The five major contracts are with the University of Massachusetts Medical School, Worcester, MA; University of Georgia, Athens, GA; University of California, Berkeley, CA; University of Maryland, Baltimore, MD; and California Department of Health, Sacramento, CA. Thirty-three other contracts are also supported in the amount of \$3,155,963.

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Developed effective procedure for serotyping group A meningococci, providing tool for epidemiological surveillance of diseases in troops. Completed development and initial production of meningococcal polysaccharide vaccines for types A and C diseases which reach epidemic levels in recruits and result in multiple days lost from training. Demonstrated use of hyperbaric-glucose-amphotericin in the treatment of coccidioid meningitis. Reduced incidence

Project: #A802

Program Element: #6.27.70.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Preventive Medicine

Title: Military Infectious Disease Technology

Budget Activity: #1 - Technology Base

and morbidity of adenovirus infections in recruit centers with vaccine against types 4 and 7 adenovirus diseases, leading to significant training cost savings. Identified adenovirus type 21 as a possible emerging strain of adenovirus. Evaluated adenovirus type 21 vaccine for efficacy in preventing significant outbreaks of acute respiratory disease (ARD) in recruits during basic combat training. Tested first production lot of Dengue 2 vaccine for safety and efficacy in lower primates and an investigational new drug application (IND) prepared for human trials. Documented changes in Dengue subtypes causing hemorrhagic fever in overseas endemic areas which explain recent increase of Dengue in Thailand. Characterized an antiserum prepared for strains of swine influenza in military personnel. A new radioimmunoassay for hepatitis B identification in serum has retained the necessary sensitivity and increased the specificity for detection of this virus. Completed basic epidemiological studies of infectious diseases in populations of a newly colonized transamazon tropical area of Brazil. Documented Oropouche virus attack rates of 40% during urban epidemics in tropical area of South America. Studies arthropod-borne diseases in tropical and subtropical areas and data established on the vectors of malaria, arbovirus diseases, and filariasis in Southeast Asia. Completed engineering study of a new, improved, battery-powered light trap for field surveillance of mosquitoes and sand flies, which are vectors of malaria, arboviruses, filariasis, and leishmaniasis. Determined effective dosages for four candidate insect repellants by a newly developed bioassay on human skin against vectors of leishmaniasis, a severe disease of troops operating in endemic areas. Simplified models of the dynamics of mosquito-vector populations were developed and related to control technology. Evaluated several hundred compounds for efficacy in repelling insect vectors; best chemicals will be evaluated in field tests. Proved the feasibility of malaria vector control by the sterile-male mosquito control technique. Developed techniques for the isolation and purification of malarial ookinets from mosquitoes. Identified diarrhea-causing properties of *E. coli* and *Salmonella* bacteria. Published catalog of world mosquitoes and a comprehensive manual for identification of malaria vectors in Thailand. Developed laboratory colony of host snails for rearing large numbers of schistosome cercariae, which was a significant breakthrough in providing sufficient test animals for screening antischistosomal prophylactic drugs. Successfully immunized animals with irradiated trypanosome vaccines. Dogs as sentinel animals in endemic areas can be used for detecting infection dynamics of scrub typhus and murine typhus.

2. FY 1979 Program: Conduct worldwide epidemiological surveillance of meningococcal disease in military personnel to provide advance data of epidemics. Conduct primary evaluation studies on a vaccine against dysentery. Conduct epidemiological evaluations of arboviruses which affect operations in temperate and tropical regions. Develop radioimmunoassay procedure for use in identifying viral disease pathogens of strategic areas of Africa. Complete efficacy and safety evaluations in animals for dengue types 1 and 2 vaccines and investigational new drug (IND) applications needed for human testing for prophylaxis against these two rapid debilitating diseases of troops will be prepared. Complete final efficacy tests and initial production of adenovirus type 21 vaccine for recruit protection; provide data on prophylactic effects of combined types 4, 7, and 21 vaccines for preventing epidemics of ARD in recruits. Further develop a mosquito-virus model for determining the mechanisms involved in the overwintering of pathogenic arboviruses. Publish catalog of world mosquitoes to provide data necessary for advanced studies of mosquito-borne diseases. Evaluate wild rodent, chigger, and human scrub typhus strains so that data can be obtained for use in early developmental studies of a vaccine. Proceed with new insect vector field



Project: #A802

Program Element: #6.27.70.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Preventive Medicine

Title: Military Infectious Disease Technology

Budget Activity: #1 - Technology Base

surveillance light trap through following milestones: engineering fabrication, maintenance evaluation, and developmental testing. Test candidate insect repellents under field conditions for improved effectiveness and durability in providing personal protection to the soldier from disease vectors, especially during highly mobile combat operations. Complete development for an integrated pest management (IPM) program concept used in controlling mosquito vectors of diseases which seriously affect troop operations. Prepare and publish for use by field vector control teams identification manual of malaria vectors of Central and South American tropics. Evaluate a newly developed prophylactic drug in a large-scale field test for preventing malaria in troops operating in endemic disease areas. Complete an illustrated key to new world vectors of leishmaniasis; publish for use in identifying these insects by medical personnel. Characterize host immune mechanisms to trypanosomes; determine antigens responsible for immunity so a candidate vaccine against African trypanosomiasis can be prepared for testing in animals. Complete development of an animal model; utilize in evaluation of an experimental vaccine against African trypanosomiasis. Establish a two-year selective screening program to evaluate a large number of drugs in several chemical classes for prophylactic activity against schistosomiasis, a disease second only to malaria in causing morbidity and mortality in tropical and subtropical regions.

3. FY 1980 Planned Program: Maintain arbovirus reference center on contract to provide identification of viral diseases and to provide reference reagents for Army field teams. Complete Investigational New Drug Application (IND) reports; submit to Food and Drug Administration (FDA) on Dengue vaccines; after approval, initial human prophylactic evaluations will be completed. Initiate preclinical trials for scrub typhus vaccine, clinical trials of infectious diarrhea vaccine and develop vaccine for prevention of leishmaniasis for human application. Determine vector-pathogen-host relationships for scrub typhus in an endemic area of Malaysia; apply data for developing disease prevention and vector control procedures. Prepare technical data package for new insect vector surveillance light trap used by preventive medicine field teams. Develop and test a toxicant for impregnation into the military field uniform for protection of the soldier against blood-feeding insects and arthropod vectors of disease. Develop technical concepts and operational employment procedure of IPM mosquito vector control program. Complete taxonomic aids for use in identification of mosquito vectors of arboviruses occurring in the Middle East and Amazon region. Using animal models, evaluate drugs developed in the antimalarial program having antiparasitic activity for prophylaxis against other diseases causing soldier ineffectiveness or death. Complete development of a diagnostic procedure for early detection of leishmaniasis in troops operating in endemic areas. Complete laboratory development for a potential vaccine against African trypanosomiasis, a serious disease occurring in much of Africa between 15°N and 20°S latitude. Personnel to be utilized - 224; 141 professional, 83 support.

4. FY 1981 Planned Program: Define epidemiology of pathogens causing tropical diseases in strategic geographical regions; the bionomics and transmission cycles of their vectors. Descriptive manuals will be published on mosquito vectors of selected areas of Africa. Assess bacterial disease risks to soldiers conducting field operations in endemic areas. Evaluate a pesticide-impregnated fatigue uniform under natural insect and environmental conditions for efficacy in preventing insect-borne diseases. Complete laboratory evaluation and initiate field tests for an integrated pest control program for mosquito vectors. Complete primary prophylactic studies in volunteers for Dengue vaccines; prepare technical report. Test for efficacy and safety candidate

Project: #A802  
 Program Element: #6.27.70.A  
 DoD Mission Area: #131 - Medicine and Life Sciences  
 Title: Military Preventive Medicine  
 Title: Military Infectious Disease Technology  
 Budget Activity: #1 - Technology Base

African trypanosomiasis vaccine in primates; collect required data for evaluation in humans. Ready for fielding rapid diagnosis of leishmaniasis (serology or culture). Ready infectious diarrhea vaccine and scrub typhus vaccine for preclinical trials. Continue studies to be directed to development and evaluation of data and products which can be used effectively in control strategies of infectious diseases responsible for morbidity and mortality of troops in training and combat operations.

5. Program to Completion: This is a continuing program.

6. Major Milestones: Not applicable.

7. Resources (\$ in thousands):

	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Cost
NOTE						
Funds (current requirements)	6651	7820	8212	7654	Continuing	Not Applicable
Funds (as shown in FY 1979 submission)	7348	7820	7726	-	Continuing	Not Applicable

Decrease in FY 1978 funding reflects internal reprogramming within this program, FY 1980 increase represents shift in emphasis from drug developmental studies to research on basic mechanism of microbial interactions required for comprehensive efforts in military preventive medicine.

# FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.71.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Psychiatry and Microwave Injury  
Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
A804	Military Psychiatry		1686	1877	2964	5223	Continuing	Not Applicable
A805	Microwave Injury		873	1040	2092	3775	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** Psychiatric casualties represent a major loss of combat manpower, especially in critical high intensity operations. Increasing use of microwaves in military systems imposes additional unknown neuro-physiological burden on soldiers in combat and in training. Requirement exists to enlarge understanding of effects of combat psychological stress factors and to assess the bioeffects of Army microwave systems to prevent attrition of combat critical manpower. Knowledge is essential for development of health hazard avoidance/preventive strategies.

**C. BASIS FOR FY 1980 RDTE REQUEST:** The Army has requirements for research to minimize the impact of neuropsychiatric factors which limit soldier effectiveness. Microwave research is required to establish an adequate technology base which allows for early medical input to radar systems design, ensure production of safe systems, avert fielding delays, and provide guidelines for development of safety standards.

## D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
	2620	2917	3242	Continuing	Not Applicable

Decreased funding in FY 1978 is the result of minor reprogramming to meet urgent higher priority requirements. Increased funding in FY 1980 is the result of a redirection of efforts to assess the impact of drug and alcohol abuse on individual performance and unit readiness, to accelerate health hazard assessment of continuous and pulsed microwave systems, and to initiate hazard assessment of developmental phased array millimeter wave systems. No safety standards or assessment technologies exist for the latter, and inability to define safe use may seriously restrict the use of current and developmental systems.

## E. OTHER APPROPRIATION FUNDS: Not applicable.



Program Element: #6.27.71.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Psychiatry and Microwave Injury

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The Israeli experience has shown that the nature and intensity of combat on future battlefields will produce greater numbers of neuropsychiatric casualties than previously experienced. The individual soldier will be subjected to added stresses, to include: the threat of and actual exposure to more lethal and incapacitating weapons; complex performance requirements imposed by the use of advanced weapons systems and doctrine; physical and emotional demands prompted by engagement in high intensity continuous and sustained operations; and jet-lag performance decrements resulting from rapid transmeridian troop deployment. Methods that will maintain soldier effectiveness must be addressed. The impact of other factors which are currently threatening to compromise operational readiness and combat effectiveness must be assessed. These include the suspected increase in drug abuse among our troops in Europe and the impact of drug and alcohol abuse on readiness; the extremely high (45%) first-term enlistment attrition rates; and evidence of possible increased female soldier maladjustment. Microwave technology is employed extensively by the military in the fields of communications and electronics. All radar systems (e.g., Hawk, Roland, Nike Hercules) use microwaves. Personnel are exposed to high-powered microwave sources in training and in field operations which pose unknown but probably substantial risk. Many new systems employing microwave emitters are currently being developed. Emerging techniques are leading to development of medical materiel employing radio-frequency and microwave radiation for diagnostic and treatment purposes which are of marked interest to the military. Recent public alarm and health concerns within the medical community and federal regulatory agencies have focused on the genetic, carcinogenic, and ocular effects of microwaves. At present, there is a serious lag in the development of an adequate microwave technology base with which to assess the health hazards of microwave exposure. Current safety standards are not applicable to systems being developed. Regulatory agency interest may severely restrict existing systems due to inability to define safe use levels.

G. RELATED ACTIVITIES: While there is a broad interest in and support of research dealing with psychiatric illness, stress induced performance decrements, and microwave injury, the problems dealt with under this program element are militarily unique. The Army furnishes representatives to the Department of Defense Drug and Alcohol Abuse Research and Development Liaison Group. This Liaison Group interacts with the National Institutes of Health's Alcohol Drug Abuse and Mental Health Administration (ADAMHA) which oversees the activities of the National Institute on Drug Abuse (NIDA) and National Institute on Alcohol Abuse and Alcoholism (NIAAA). This Group provided NIDA with a breakdown of proposed drug and alcohol abuse research projects of interest to DOD. In addition, an Army representative attends the NIDA/NIAAA Study Sections to keep abreast and assess areas of interest with potential military applications. An extensive network of formal and informal relationships with other governmental agencies and Army medical laboratories is maintained. US Army Medical Research and Development Command scientists participate in international study groups such as NATO's Advisory Group for Aerospace Research and Development and the Technical Coordination Program. Collaborative studies of stress-induced performance decrements are conducted with the US Army Research Institute of Environmental Medicine. The US Army, Navy, and Air Force have established a Tri-Service Electromagnetic Radiation Plan under the guidance of the Under Secretary of Defense for Research and Engineering. The plan is updated periodically and is intended to ensure the proper allocation of limited resources to the highest priority tasks identified by all three services. To this end the three services emphasize the sharing of laboratory facility use whenever possible. Army maintains formal facility use agreement with the Bureau of Radiological Health, Environmental Protection Agency, and the Armed Forces Radiobiology Research Institute. In addition, Army maintains a program with DOD/Electromagnetic Compatibility Analysis Center to keep apprised of Army special utilization and operational system configurations.

Program Element: #6.27.71.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Psychiatry and Microwave Injury

Budget Activity: #1 - Technology Base

H. WORK PERFORMED BY: University of Western Ontario, Ontario, Canada; University of Florida, Gainesville, FL; University of Pennsylvania, Philadelphia, PA; Georgia Technological Research Institute, Atlanta, GA; University of Georgia, Athens, GA. Four additional contracts for a total of \$187,279. In-house research is performed by Walter Reed Army Institute of Research, Washington, DC.

#### 1. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Reorganized the military psychiatry research program and developed a research plan oriented around combat psychiatric casualty management. Established a field research unit to study military psychiatric problems related to US Army, Europe. Developed research plans to study psychiatric problems associated with troop deployment to Europe. Assessed neuropsychiatric aspects of continuous operations with field artillery teams. Developed a procedure for evaluating the long-term effects of LSD administered to human subjects in Army chemical/psychoactive agent studies dating back to the 1950's. Development completed on patented prototype microwave transparent heat sensing implantable electrode for greatly improved accuracy in measurement of microwave induced heat elevation in living animal and human tissues. Preliminary development completed on an implantable electrode to detect microwave-induced electrical fields in simulated human tissue. Conducted basic studies on noninvasive dosimetric method for estimating the amount and location of microwave-induced energy absorbed in simulated human tissue; this technique defines the dielectric constant of tissue by delaying microwave propagation (patent pending). Conducted analytical studies on power density contour for typical radar sites of three fielded systems: Improved Hawk, Nike, and US ROLAND. Data was used to conduct a theoretical health hazard assessment of operating personnel. Developed basic instrumentation to measure central nervous system effects of microwaves using both continuous wave and pulsed microwaves. Conducted problem definition study and formulated research plan for microwave-induced alterations in the blood-brain barrier.

2. FY 1979 Program: Assess psychological, physiological, and social factors involved in adapting to rapid translocation, (e.g., rapid deployment). Determine critical factors limiting performance during continuous or sustained military operations. Identify neuropsychiatric factors influencing first-term attrition. Define factors in the Army environment which influence the rate of psychiatric illness among female soldiers. Study psychological, physiological, and social factors associated with psychiatric breakdown in civilian disasters, life-threatening situations (e.g., firefighting), and heavy workload situations. Reinitiate medical research efforts on drug and alcohol abuse in the Army, with emphasis on establishment of research priorities and staffing requirements. Conduct feasibility study of wireless telemetry method to transmit data from microwave heat and electrical field sensing electrodes. Conduct noninvasive dosimetric studies to generate three dimensional maps of microwave energy absorption in isolated animal organs. Begin preproduction of microwave heat-sensing implantable electrode. Develop prototype implantable electrode for detection of microwave-induced electrical fields in simulated and actual tissues. Conduct power density contour analytical studies in health hazard assessment of operating personnel in support of PATRIOT, TPQ-36 (mortar-locating radar), and TPQ-37 (artillery-locating radar). Study central nervous system effects of continuous and pulsed microwave exposure on nerve impulse propagation in marine invertebrate models. Develop basic instrumentation for blood-brain barrier effects and microwave-induced cataract formation studies. Compare effects of continuous wave and pulsed microwave on cell membranes. Design apparatus to measure microwave exposure of ocular lens epithelial cells in tissue culture.

Program Element: #6.27.71.A  
DoD Mission Area: #111 - Medicine and Life Sciences

Title: Military Psychiatry and Microwave Injury  
Budget Activity: #1 - Technology Base

3. FY 1980 Planned Program: Determine impact of rapid translocation on soldier performance and unit readiness. Assess patterns of drug and alcohol use/abuse in the Army and the impact on performance and readiness. Conduct field studies to validate factors influencing the rate of psychiatric illness among female soldiers. Conduct field validation of psychological and social factors which influence first-term attrition. Develop measures for minimizing performance decrements and enhancing soldier effectiveness during continuous operations. Assess individual responses to life-threatening and heavy-workload situations, including identification of factors predisposing towards psychiatric breakdown. Develop field deployable physiological monitoring systems for use in studies of continuous operations. Develop prototype wireless telemetry model for data transmission from heat and electrical fielding sensing electrodes to various recording systems. Begin full-scale production of 100 microwave transparent heat-sensing implantable electrodes. Begin preproduction of the implantable electrode (10 - 20 items) for detection of induced electrical fields. Conduct advanced biological testing of central nervous system effects in marine invertebrate models using fluorescent techniques to characterize nerve impulse propagation changes during continuous wave and pulsed microwave exposures. Conduct blood-brain barrier research to examine effects of microwave exposure on red blood cell permeability to various substances. Conduct preliminary biological studies on lens cataract formation. Study effects of continuous wave and pulsed microwave on differentiation of lens epithelial cells. Approximately 36 professional personnel and 45 support personnel will be utilized for this program.
4. FY 1981 Planned Program: Assess impact of major changes in unit status on patterns of drug and alcohol abuse. Develop measures to prevent psychiatric breakdown in life-threatening situations. Develop recommendations for minimizing attrition among first-term recruits. Develop operational procedures to minimize adverse effects of rapid translocation. Initiate efforts to establish a data base for predicting psychiatric casualties and to optimize rapid return to duty. Begin manufacture of pre-production wireless telemetry models for data transmission from microwave electrodes to recording systems. Begin full-scale production of implantable electrode model (100 items) for detection of induced electrical fields. Conduct blood-brain barrier research to characterize membrane permeability changes in various cell types due to microwave exposures. Examine possible additive effects of multiple microwave exposures upon lens epithelial cells by scanning electronmicroscopy to predict possible eventual formation of cataracts.

5. Program to Completion: This is a continuing program.



FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.72.A

DoD Mission Area: #131 - Medical and Life Sciences

Title: Recovery from Injury  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>6903</b>	<b>5642</b>	<b>4957</b>	<b>6789</b>		
A810	Military Skin Disease	730	238	0	0	Not Applicable	Not Applicable
A811	Military Nutrition and Food Hygiene	1471	1852	0	0	Not Applicable	Not Applicable
A812	Military Research Animal Resources	559	655	0	0	Not Applicable	Not Applicable
A813	Health Effects of Military Lasers	1087	0	1492	3722	Continuing	Not Applicable
A814	Military Trauma and Resuscitation	2547	2290	3465	3067	Continuing	Not Applicable
A815	Combat Surgery	509	607	0	0	Not Applicable	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** Research program is based in part on the requirement to develop a medical system capable of rapidly returning casualties to duty. Soldiers returned by the medical system will provide the only source of trained replacements for field commanders during critical first days of combat. Program also addresses materiel developer requirements for health hazard assessment and development of human tolerance criteria for laser systems.

**C. BASIS FOR FY 1980 RDTE REQUEST:** Funds are required for a second-year program directed at development of triage (medical sorting) prehospital treatment methods in support of requirements for far-forward medical care. Funds for laser research will be focused primarily on hazard assessment in support of Multiple Integrated Laser Engagement System (MILES) and the family of laser range finders/designators.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Cost
Funds (as shown in FY 1979 submission)	7471	3790	1445	Continuing	Not Applicable

Program Element: #6.27.72.A  
DoD Mission Area: #131 - Medical and Life Sciences

Title: Recovery from Injury  
Budget Activity: #1 - Technology Base

Change in FY78 program due to reprogramming actions in support of technologies effort in vaccine production base. Change in FY 1979 figures for military nutrition and food hygiene project reflects congressional action to continue nutrition research for one more year. The conferees were in agreement that the program be transferred to the Department of Agriculture following FY 1979 terminal year funding as part of the Department of Defense Appropriations Bill. Project increase in FY 1980 over FY 1979 for health effects of military lasers is a result of laser system health hazard assessment research being given high priority for funding. Increase in the trauma and resuscitation project is in part due to program restructuring which incorporated the combat surgery project as well as Program Element 6.27.74.A, Military Burn Technology.

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.72.A

DoD Mission Area: #131 - Medical and Life Sciences

Title: Recovery from Injury

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: Major thrusts are concerned with trauma and resuscitation and the health effects of military lasers. The first is concerned with research and development required for the discovery, diagnosis, initial resuscitation, treatment, evacuation, hospital management, and return to duty of the injured or diseased soldier. The modern battlefield is expected to produce increased numbers of and more severe casualties, with replacements in short supply. Program emphasis is placed on rapid return to duty of combat casualties to provide field commanders with the maximum number of replacements. Projects focus on new methods for far-forward resuscitation, triage (medical sorting), and prehospital treatment, particularly those methods appropriate for self-help, buddy aid, and nonphysician field care. The second thrust is the determination of biological effects of lasers to meet the increased use of lasers in military weapons systems; e.g., range finders, designators, and training devices. A technology base is required on the bioeffects of laser exposures characterized by wavelength, beam divergence, energy output, pulse rate and duration. Specific laser systems must be studied to determine safety factors peculiar to the system. Approach is to expose animals to laser beams, making direct observations of the exposed eyes to detect damage to cornea, lens, and retina with subsequent microscopic examination to characterize damage. Skin exposures are also observed.

G. RELATED ACTIVITIES: Technology base for this program is maintained under Program Element 6.11.02.A, Defense Research Science Army. Related nonduplicative research is conducted by other government agencies, institutes, universities, and other federal services. Continual coordination and review of related research by technological summaries, periodic program reviews, joint medical research conferences, literature review, etc., insure that there is no duplication.

H. WORK PERFORMED BY: In-house research will be performed by the Letterman Army Institute of Research, Presidio of San Francisco, CA, and the US Army Institute of Surgical Research, Fort Sam Houston, TX. Major extramural contracts to be supported with FY 1979 monies are with Vector Research, Inc., Ann Arbor, MI; Yale University, New Haven, CT; Albert Einstein College of Medicine, New York, NY; Columbia University, New York, NY; and City of Hope National Medical Center, Duarte, CA. Approximately twenty-five additional extramural projects will be supported with FY 1979 monies at an estimated cost of \$1245K.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Established rhesus and owl monkey breeding colonies. Completed initial studies to more fully characterize laser-induced retinal lesions which are related to impaired color vision and visual acuity. Demonstrated burn wound biopsy to be an effective tool in evaluating bacterial invasion. Improved clinical diagnosis of inhalation injury and identification of population at risk. Provided health hazard data for gallium arsenide laser required in preparation for operational testing of the Multiple Integrated Laser Engagement System (MILES). Characterized the formation of cataracts due to single and repeated laser exposures. Completed first survey of a new feeding system of anesthetic agent interactions with shock and hypoxia. Developed and initiated human trials of an antiserum against bacterial endotoxin. Developed stroma-free hemoglobin and demonstrated the potential "blood substitute" to be capable of supporting life after blood volume replacement. Developed and licensed an improved liquid blood preservative extending the shelflife of banked blood.



Program Element: #6.27.72.A

DoD Mission Area: #111 - Medical and Life Sciences

Title: Recovery from Injury

Budget Activity: #1 - Technology Base

2. FY 1979 Program: Terminate project directed toward development of research animal breeding colonies. Conclude research on military skin disease; incorporate minimum essential elements into Program Element 6.27.70.A, Military Infectious Disease Technology. Accelerate the majority of ongoing nutrition and food hygiene studies and bring to an orderly conclusion. Maintain the resulting phased-down nutrition research capability under Program Elements 6.11.02.A, Defense Research Sciences, and 6.27.24.A, Joint Services Food System Technology. Determine actual future research projects in response to requirements of the DOD Food Service Program. Maintain, during FY 1979, laser research technology base under Program Element 6.11.02.A. Expand research focusing on military trauma and resuscitation with emphasis on: (1) increasing far-forward medical care capabilities; (2) rapid return to duty of combat casualties; and (3) medical operations under conditions of limited patient evacuation. Restructure and incorporate research previously identified under the combat surgery project and Program Element 6.27.74.A, Military Burn Technology, into far-forward medical care program. Address specifically triage (medical sorting) criteria, early prevention of shock and infection, improved anesthesia techniques, and prehospital treatment technology to decrease evacuation requirements.
3. FY 1980 Planned Program: Continue focus (year 2) on triage (medical sorting) criteria and prehospital treatment methods central to effective far-forward medical care. Studies directed toward increased prehospital capabilities will include development of synthetic skin substitutes, prevention of infection, continued development of blood substitutes, improving regional anesthetic techniques, and controlling hemorrhage. Expand research on the health effects of military lasers. Determine retinal damage thresholds for gallium arsenide laser exposures in support of the Multiple Integrated Laser Engagement System (MILES). Focus additional laser studies on tank and helicopter ranging from designating systems. Initiate investigation of laser protective materials to determine their potential for use in optical devices. Anticipated personnel to be utilized for this program are 141 professional, and 51 support.
4. FY 1981 Planned Program: Continue to focus on development of treatment techniques which will permit rapid return to duty rather than lengthy evacuation of combat casualties. Accelerate shock prevention and control projects. Initiate preclinical trials of stroma-free hemoglobin. Identify potential materials for use in optical devices for protection against multiple laser wavelengths. Initiate chronic low-level exposure studies to examine possible additive effects of various laser wavelengths.
5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.73.A  
DoD Mission Area: #131 - Medicine and Life Sciences  
Title: Helicopter Combat Crew and Airborne Medicine  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
<u>TOTAL FOR PROGRAM ELEMENT</u>							
A818	Medical Effects of Blast Overpressure	1439	0	0	0	0	1439
A819	Helicopter Combat Crew and Airborne Medicine	2127	2211	2915	4331	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Newly fielded and developmental Army weapons systems are more technologically complex, often exceeding the physiological capability of the operator/crew. Health hazards and/or performance degradation may result, nullifying the investment in weapons development. Requirement exists to identify such equipment - associated health hazards, to establish medical data bases for development of hazard exposure criteria and determination of adequacy of engineering design and medical protective measures. Need is especially acute in connection with aviation, airborne and crew-served combat vehicle systems.

C. BASIS FOR FY 1980 RDTE REQUEST: Program is vital to the Army's combat readiness posture. It provides medical input for safe equipment design, provides rationale for protective clothing and equipment, and enhances soldier survivability and performance.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Cost Not Applicable
	3476	2211	2450	Continuing	Not Applicable

Program Element: #6.27.73.A  
DoD Mission Area: #131 - Medicine and Life Sciences

Title: Helicopter Combat Crew and Airborne Medicine  
Budget Activity: #1 - Technology Base

Basis for change: Increased funding in FY 1978 is the result of minor reprogramming to meet urgent higher priority requirements. Increased funding in FY 1980 is a result of redirection of efforts to address the serious lag in development of an adequate technology base for health hazard assessment of high priority Army systems. Main portion of funds will be directed to further studies of the medical effects of blast overpressure (impulse noise) in support of the M198, M110, M109 artillery systems to avert fielding delays. A small effort will be devoted to additional medical research in support of the Advanced Attack Helicopter (AAH), Advanced Scout Helicopter (ASH), High Survivability Test Vehicle/Lightweight (HSTV/L), High Maneuverability and Agility Test Vehicle (HIMAG), ROLAND, DRAGON, and Improved TOW Vehicle (ITV).

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.27.73.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Helicopter Combat Crew and Airborne Medicine

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: As the complexity of new weapons systems increases, new tactics and doctrine for employment are developed, more realism in combat training is achieved, and increased stress is placed on the individual soldier and combat crewman. As a result, weapons systems and employment techniques may exceed the physiological, physical, perceptual, psychomotor, and psychological capacities of the soldier. Most presently fielded and all developmental weapons may pose temporary or permanently disabling health hazards to the crew/operator. Medical research meets a requirement to ensure the safety of the soldier, enhance his effectiveness, and protect his health. Research includes performance measures and workload assessment under training conditions, analysis of acoustic environments of weapons, bioengineering of air and ground combat vehicles and life support equipment, study of eye-protection technology and vision enhancement, aviation/combat crew medicine, and medical effects of blast overpressure. Blast overpressure studies were supported by Project A818 until FY 1979 when the former project was collapsed into A819.

G. RELATED ACTIVITIES: Technology transfer and research coordination exist through Intra-Army and Tri-Service agreements, regulations, and informal meetings to mutually complement joint requirements. Medical research is keyed to weapons systems Project Manager milestones. As an example, medical technology in support of Army aviation problems is specifically related to various Air Force and Navy aviation medicine requirements and is also transferable into technology for solution of armor and artillery problems. A memorandum of understanding between the US Army Medical Research and Development Command and the Human Engineering Laboratory will now ensure adequate medical/human factors input for Army Systems Acquisition Review Council (ASARC)/Defense Systems Acquisition Review Council (DSARC).

H. WORK PERFORMED BY: In-house research is performed by US Army Aeromedical Research Laboratory, Fort Rucker, AL. Extramural research is performed by Jaycor, Del Mar, CA; and University of Oklahoma, Oklahoma City, OK.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Biomedical design and review of the troop seat contributed to the crashworthy design of the UH-60 helicopter. Developed medical technology for evaluation of human visual system integration with Advanced Attack Helicopter (AAH) target acquisition technology. Developed blast tube to cheaply and efficiently simulate artillery weapons blast overpressures for animal model studies. Developed automated data acquisition and reduction system for recording and quantifying blast overpressures in laboratory studies. Refined electromyographic techniques to analyze muscle stress induced by whole-body vibration in flight environments. Developed prototype computer device for assessment of night visual acuity. Validated feasibility of onboard oxygen-generating equipment for helicopters operating at high altitudes. Developed animal model for laboratory stimulation of task performance in vibrating vehicle environments. Developed methodology for assessment of man-machine integration of electrooptical systems in developmental aircraft.

Program Element: #6.27.73.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Helicopter Combat Crew and Airborne Medicine

Budget Activity: #1 - Technology Base

2. FY 1979 Program: Develop assessment capability of low frequency vibration hazards for new generation combat vehicles. Refine medical technology for development of hearing protection without communications impairment. Provide biomedical support to major new systems developers in health hazard assessment of steady-state and impulse noise, vibration, and toxic fumes (XM-1 Tank and XM-2 Fighting Vehicle). Establish relationships between artillery blast overpressures and nonauditory injury in large animal model. Study incidence of high-frequency hearing loss produced by low-frequency noise of combat vehicles to develop protection criteria. Conduct health hazard assessment of AAH to avert fielding delay. Evaluate adequacy of life support equipment in operational environments and recommend design changes and improvements. Establish Army aircrew selection, retention, and physical performance criteria based on task performance, workload, crew staffing and flight hour limits in attack helicopters. Assess visual problems involved in integrating man with electrooptical systems, heads-up displays, perceptual workload, night visual acuity, and dark adaptation.
3. FY 1980 Planned Program: Define health exposure criteria to blast overpressure associated with artillery weapons. Validate criteria with human research model. Conduct complete medical evaluation and health hazard assessment of High Survivability Test Vehicle/Lightweight (HSTV/L) as part of the beginning of medical support for the Advanced Armor Technology Program. Assess adequacy of design criteria for new generation combat vehicle crewman clothing ensembles. Refine medical technology for feasibility testing of helicopter escape systems and seat design in vertical takeoff and landing airplanes. Provide medical technology for integration of advanced hearing protection modules and with ballistic and bump protection features in personnel helmets. Conduct medical research to increase crashworthiness of AH-1 Cobra helicopter. Determine optimal display characteristics to match the capabilities of the human visual system for new technology weapons systems acquisition. Expand scientific data base on the neurophysiology of human auditory and visual senses relevant to the military environment. Develop physiological and psychological indices of aviator alertness and fatigue during sustained flight operations. Professional personnel for this effort: 66; support personnel: 57.
4. FY 1981 Planned Program: Conduct medical design review and health hazard assessment of Advanced Scout Helicopter (ASH) or potential Interim Scout Helicopter (OH-58C Helicopter Product Improvement Program). Provide human exposure criteria for vibration in armored vehicles. Acquire data base for validation or revision of existing health criteria for exposure to impulse and steady-state noise in military vehicles in response to ever-increasing severity of hazards resulting from advancing technology and combat requirements. Develop valid health exposure criteria for impact injury during low-performance inflight escape at low altitudes. Fully study the relationship between the incidence of high-frequency hearing loss and the low-frequency vibration which is found in helicopters and armored vehicles. Acquire and maintain a technology base on human performance capabilities and limitations in manned systems during military operations. Apply medical technologies to visual, psychological, and psychomotor workload and performance models and develop criteria to enhance systems design effectiveness.
5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.75.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Combat Maxillofacial Injury

Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total	
								Estimated Costs	Not Applicable
A825	Combat Maxillofacial Injury	1088	1088	1260	1258	1269	Continuing	Not Applicable	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: To develop simplified techniques which allow rapid and effective treatment of maxillofacial casualties and dental diseases as will be encountered in the high intensity conflict expected in a future war. To develop required military information on epidemiology, etiology, clinical treatment, and the prevention and control of oral disease and to use this information as the basis for research. To conduct research in the physical, clinical, and chemical properties of various dental materials, to develop techniques to improve clinical delivery of materials under variable environmental conditions, to develop optimal performance appliances and restorations, and to prepare and report developments in dental materials to the Army dentist.

C. BASIS FOR FY 1980 RDTE REQUEST: Continuation of both short and long term in-house and extramural studies which are acquiring information necessary to solve problems both in preventing oral disease and injury, and in providing improved care of maxillofacial combat injuries.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARY: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total	
					Estimated Cost	Not Applicable
	1155	1260	1339	Continuing		

FY 1978 funding profile decrease reflects internal reprogramming to higher priority, mission-relevant research. FY 1980 decrease is the direct result of refined cost estimates.

E. OTHER APPROPRIATION FUNDS: Not applicable.



Program Element: #6.27.75.A  
DoD Mission Area: #131 - Medicine and Life Sciences

Title: Combat Maxillofacial Injury  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The high incidence of combat maxillofacial injury and oral disease with their associated trend of higher treatment costs and lost duty time dictate research efforts toward reducing duty time lost and rapidly returning injured troops to duty. Areas of investigation include: materials for immediate and delayed management of combat maxillofacial wounds; improved means of administering analgesia to the dental complex in a combat area; and development of techniques and materials for prevention of dental emergencies in the combat area. The information gained from these research efforts is used to conserve limited military funding by increasing the productivity of dental professionals, improving immediate treatment in combat situations, decreasing morbidity, increasing quality of care, and decreasing the clinical treatment and hospitalization time.

G. RELATED ACTIVITIES: Army efforts related to this program element are performed under Program Element 6.11.02.A/BS06, Combat Dental Materials and Techniques. Related, but non-duplicative, research is conducted by the US Navy, US Air Force, and the National Institute of Dental Research. Coordination of research is achieved by consultations between participants, project officer visits, review of research and technology summaries, periodic program reviews, and reviews of scientific publications both military and civilian. In addition, liaison memberships are held on the National Advisory Dental Research Council and the Oral Medicine and Biology Study Section, National Institute of Dental Research.

H. WORK PERFORMED BY: The majority of effort is conducted by the US Army Institute of Dental Research, Washington, DC. Another Army laboratory providing assistance is the Chemical Systems Laboratory, Edgewood Arsenal, Aberdeen Proving Ground, MD. The remaining funds are used for extramural contracts. The top five contractors are: Rush St. Lukes-Presbyterian Medical Center, Chicago, IL; Dynell Electronics, Inc., Melville, NY; University of Oregon Health Science Center, Portland, OR; Battelle Memorial Institute, Columbus, OH; and the Franklin Institute Research Laboratories, Philadelphia, PA. Four additional contracts are supported representing \$170,000.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Developmental efforts with the presurgical handwisher have continued to yield significant data, an offshoot of which is the possibility of radioactivity decontamination. Efforts addressing biodegradable copolymers, their degradation rates, tissue compatibility, and structural properties are at advanced stages and being expanded and continued in new models. Clinical testing of the dental pulp vitalometer has been initiated. Less expensive dental restorative materials suitable for militarily unique application were identified and evaluated. Biodegradable ceramic materials studies have continued to yield data useful in human/military application. The insertion phase of the titanium implant studies used as a model for fracture immobilization devices has been completed. High power CO<sub>2</sub> laser studies were initiated to evaluate/utilize the device for use in combat wound treatment. Development of biocompatible material for tissue augmentation in maxillofacial combat wounds was initiated. Work addressing fluoride compound configurations and their use in topical application for prevention of needless dental emergencies in combat situations was initiated. The preliminary studies addressing the effects on the hard tissues of the maxillofacial complex of high velocity missiles at 6000 fps and 55 grain size have been completed. Efforts were initiated to apply field salivary diagnostic tests for the detection of chemical agents. Technical development of a 3-dimensional imagery

Program Element: #6.27.75.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Combat Maxillofacial Injury

Budget Activity: #1 - Technology Base

continued for rapid identification of combat fatalities and transmission of wound size/type information for more rapid diagnosis and treatment. Studies of nitinol, the metal with a memory, yielded exciting possibilities related to fracture immobilization. An X-ray intensification device was devised which may provide a portable system of immediate X-ray diagnosis useful under field conditions. The drug, Sodium-2-3 Dimercaptopropionate Sulfonate (DMPS), which has been shown to be effective in treating mercury and arsenic toxicity, has also been shown to be useful in nickel, cadmium, and copper detoxification.

2. FY 1979 Program: Continue collection of data on the effects of high velocity missile wounds as related to missile size in the maxillofacial complex. Continue collection of human data with free-standing metallic implants, both as a fracture immobilization device and single-tooth replacement. Continue studies to develop field salivary diagnostic tests for the detection of presence of specific types of chemical agents. Further develop 3-dimensional imagery for identification of combat fatalities and transmission of data for more rapid surgical treatment of tissue distorting wounds. Apply electrolytic metal plating of teeth applications and easier techniques for preventive and restorative procedures in the combat soldier. Continue and expand investigations in animals using biodegradable copolymers as slow-release vehicles for long-term drug administration. Transfer data from past studies addressing the surgical management of combat wounds using biocompatible ceramic tooth implants to achieve comprehensive human data. Continue project to provide rapid determination of specific bacterial contamination in combat wounds. Extensive material characterizations, both biodegradable and nondegradable, will be continued and form the basis for further studies. Develop technology to identify specific organisms in combat wound contamination. Initiate study on a computer model of a man to determine tissue damage caused by various-sized missiles of differing velocities and diverse wound pathways. Continue studies using nitinol as a fracture immobilization device in animals. Evaluate a portable X-ray intensification device for use in combat situations. Consider DMPS as a heavy metal detoxicant in occupational poisonings.

3. FY 1980 Planned Program: Develop technology to determine additional uses of 3-dimensional imagery in diagnosis and treatment of tissue-distorting maxillofacial wounds. Pursue human studies utilizing ceramic and sintered titanium implants both as fracture immobilization devices and single-tooth replacements. Analyze high and ultrahigh velocity missile wound defects on the hard and soft structures of the maxillofacial complex. Continue studies in utilization of lasers in combat maxillofacial wound surgery and complete studies in the treatment of certain surface lesions. Characterization of biodegradable/biocompatible materials for maxillofacial use continues. Further develop chemical agent detection studies through salivary tests for use in a far-forward combat situation. Wound-healing studies and determination of combat wound contaminants continue. Investigations ongoing of long-term slow-release drug vehicles for use in remote combat areas. Developmental efforts using a computer model of a man for wound characterizations continue. Assessment utilizing nitinol memory metal and DMPS, the heavy metal detoxicant, continue. It is anticipated that 36 professional and 62 support personnel will be utilized for this project.

Program Element: #6.27.75.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Combat Maxillofacial Injury

Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: Complete work on maxillofacial tissue responses to high and ultrahigh velocity missiles of various sizes and shapes. Continue investigations on the computer model of a man in characterization of wound parameters. Complete efforts of the uses of 3-dimensional imagery in maxillofacial complex trauma. Continue biodegradable/biocompatible copolymer and ceramic studies for fixation, bone regeneration, slow drug release, and other biological purposes. Continue metallic and ceramic implant evaluation. Continue characterization of biodegradable/biocompatible materials for improving future biological uses. Continue work using saliva as a vehicle for the rapid identification of various chemical agents as might be utilized by the enemy in combat. Continue wound-healing and wound-contamination efforts. Evaluate materials which can be utilized in dental preventive and restorative procedures related to the unique military situation. Complete investigations of nitinol, the metal with a memory. Complete studies of DMPS, a medicament shown to be useful in heavy metal intoxications. Continue exploring electrolytic plating for the prevention of dental emergencies.

5. Program to Completion: This is a continuing program.



FY 1980 RDTF CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.76.A  
DoD Mission Area: #135 - Chemical Biological Warfare  
Title: Medical Defense Against Biological Agents  
Technology Base  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands):

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
A841	Medical Defense Against Biological Agents	9256	7564	6923	8214	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Objective of this program is to develop an effective medical defense against the use of biological weapons. This is accomplished through research on the pathogenesis of potential biological agents, rapid laboratory identification of agents, and prevention or treatment of biological agent casualties. Research studies encompass vaccine development which leads to production and stockpiling for mobilization or operational contingencies in worldwide deployment of military troops.

C. BASIS FOR FY 1980 RDTF REQUEST: This program is the sole DOD effort in the national program for medical defense against the potential use of Biological Warfare (BW) agents. Developments are utilized in mobilization and operational contingency plans. Recent Congressional hearings have emphasized the need for a strong BW defense. NATO working groups maintain cognizance of BW defense research results. The Departments of Health, Education, and Welfare, Agriculture, and the Center for Disease Control maintain an active interest in vaccine production efforts, especially in the realm of unique or exotic agents. Concentrated research efforts are necessary to further advances in prevention of biological casualties and to develop new methods of diagnosis and treatment. Expansion of vaccine production and test programs is required to improve predevelopment immunization capabilities against most likely agents.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Cost	Not Applicable
Funds (as shown in FY 1979 submission)	7663	7564	8891	Continuing		

Program Element: #6.21.76.A

DoD Mission Area: #135 - Chemical Biological Warfare  
Technology Base

Title: Medical Defense Against Biological Agents

Budget Activity: #1 - Technology Base

Increased funding in FY 1978 is reprogramming of funds to support technological efforts in vaccine production base. Decreased funding in FY 1980 is a direct result of initiation of 6.37.50.A/A808 with a concomitant reallocation of funds.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.76-A

DoD Mission Area: #135 - Chemical Biological Warfare  
Technology Base

Title: Medical Defense Against Biological Agents  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: This program is designed to develop an effective medical defense against known and potential biological weapons. Data are utilized to formulate a total medical approach for prevention and treatment of Biological Warfare (BW) casualties, identification of BW agents, and vaccine development to include production and stockpiling for use in worldwide deployment of troops. This program is the only national resource for vaccine development specifically for armed services; data base is utilized to develop techniques for mass production of candidate vaccines. More efficient methods are devised for rapid early laboratory identification as well as better methods for prevention, treatment, and drug therapy of BW agents and other highly infectious diseases affecting military operations. Investigations in aerosol immunization and protection systems against BW and other hazardous infectious diseases are a significant component of this program.

G. RELATED ACTIVITIES: Related Army studies are performed under Program Elements/DA Projects 6.11.02.A/BS01, Basic Research on Military Injury and Diseases; 6.11.02.A/BS03, Medical Defense Against Biological Agents; 6.27.70.A/A802, Military Preventive Medicine and Tropical Diseases; and 6.37.50.A/A808, Drug and Vaccine Development. This program element is the sole DOD input in the national program for medical defense against biological agents. Complementary infectious disease research conducted by the Navy, National Institutes of Health, Department of Agriculture, and the Center for Disease Control is pertinent to this program element. However, the unique aspects of Army field operations dictate an Army program which focuses on optimal support of military operations and learning to recognize, prevent, and treat diseases with significance. Army representation on Department of Defense coordination committee and other intergovernmental agency coordination councils ensures coordination at the working and administrative levels to prevent duplication of effort. Army scientists serve as consultants with the World Health Organization and have access to this organization's studies, reports, and publications. Other coordination is accomplished by personal contacts at the operating level, by site visits by project officers, organization of technical symposia on selected topics, routine exchange of reports among staff and laboratory organizations, open publication of results in scientific journals, and distribution of research and technology resumes.

H. WORK PERFORMED BY: Approximately 90% of the work is performed by the US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD, and 10% by extramural contractors including Salk Institute, San Diego, CA; Yale University, School of Medicine, New Haven, CT; and Washington State University, Pullman, WA.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Initiated work to develop rapid identification procedures for high hazard potential agents including Lassa, Congo-Crimean, and Rift Valley fever. Expanded work on diagnostic technology production and characterization of toxic bacterial exoproteins (botulinum, anthrax, staphylococcus, pseudomonas, and diphtheria). Adapted identification techniques such as chemiluminescence and ELISA radioimmunoassay for use in detecting BW infections. Completed planning phase for measures and facilities to permit diagnostic and clinical laboratory operations to function under high-hazard potential



Program Element: #6.27.76.A

Sub Mission Area: #135 - Chemical Biological Warfare  
Technology Base

Title: Medical Defense Against Biological Agents  
Budget Activity: #1 - Technology Base

Biological Warfare (BW) microbial containment conditions. Conducted long-term testing of volunteers who received experimental vaccines of importance for BW prophylaxis including those against tularemia, Q fever, Eastern equine encephalitis, and Western equine encephalitis. Initiated initial (Phase I) testing for safety and efficacy in volunteers for a new experimental Rift Valley fever vaccine. Developed industrial scale vaccine production methods of products needed for immune protection and produced six large lots of Rift Valley fever vaccine. Developed a killed Venezuelan equine encephalitis vaccine; production lots prepared and shown effective and safe in small-scale field trials in volunteers. Developed laboratory lot of candidate Bolivian hemorrhagic virus as a potential vaccine. Developed and evaluated in volunteers vaccines against Q fever, tularemia, chikungunya virus, plague, Eastern (EEE), Western (WEE), and Venezuelan (VEE) equine encephalomyelitis. Studied mode of action of staphylococcus enterotoxin and prepared experimental toxoid using molecule fragments. Prepared improved Rocky Mountain spotted fever (RMSF) vaccine which underwent preliminary evaluation in laboratory volunteers. New antiviral drugs (poly I:C, amantadine, rimantadine, and ribavirin) shown to be highly effective in prevention and treatment of influenza in test animals. Developed laboratory disease animal models for swine influenza, RMSF, and Bolivian hemorrhagic fever, and staphylococcal infections in order to study infectious disease, develop therapeutic procedures and preventive measures. A new diagnostic assay designed to measure lymphocyte subpopulations shown highly effective in evaluating immune responses to viral infections and particularly in evaluating cellular responses to vaccines. Initiated hexavalent botulinum toxoid development. Established causative agent of Korean hemorrhagic fever (KHF) in tissue culture.

2. FY 1979 Program: Evaluate and develop immunofluorescence techniques for rapid identification of arbovirus infections of troops deployed in overseas areas. Continue development of systematized procedures for rapid detection of potential viral agents in operational environments (e.g., Legionnaires' disease bacillus and Korean hemorrhagic fever virus). Develop special technology for producing microbial reagents for use in expanding BW diagnostic capabilities. Conduct advanced investigations concerning infection mechanisms, host organ localization, cellular penetration, and aerosol susceptibility to a variety of potential BW microorganisms. Test new drugs in animals for efficacy against potential BW agents. Upgrade microbial laboratory containment capabilities to initiate animal studies for developing diagnostic procedures of several highly dangerous potential BW agents. Complete Phase I testing in volunteers for evaluating a new experimental Rift Valley fever vaccine for protection against this febrile, debilitating disease which produces epidemics in a week or less. Test candidate vaccine against chikungunya virus for safety and efficacy in volunteers. Initiate Phase I testing in humans of an improved Q fever vaccine for protecting troops exposed to this potential agent. Continue development on industrial scale vaccine to produce lots of Eastern equine encephalitis and inactivated chikungunya vaccines. Complete development studies and prepare reports for obtaining approval from the Food and Drug Administration (FDA) to begin initial Phase I testing of individual botulinum toxoids for use as prophylaxis against botulism. Continue development of a hexavalent botulinum toxoid. Develop new laboratory tests for confirmation of vaccine protection. Continue new and novel nonvaccine protection studies requiring special containment facilities. Study new identified hemorrhagic

Program Element: #6.27.76.A

DoD Mission Area: #135 - Chemical Biological Warfare  
Technology Base

Title: Medical Defense Against Biological Agents

Budget Activity: #1 - Technology Base

fever viruses (Ebola, Korean, Lassa) for possible vaccine development. These have overt Biological Warfare (BW) potential and are receiving unusual interest by leading scientists of Warsaw Pact nations. Test extant encephalitis and Bolivian hemorrhagic fever vaccines in animals. Continue research on preventive therapeutic and diagnostic procedures of other high risk potential BW agents.

3. FY 1980 Planned Program: Complete evaluation of immunofluorescence procedures for detection of arboviral BW agents. Modify radioimmunoassay and ELISA procedures to provide improved diagnostic capabilities for a large variety of microorganisms of BW concern. Field test diagnostic laboratory microbiological capabilities using diverse organisms and toxins. Identify and equip mobile teams capable of evaluating potential or suspected BW incidents. Conduct threat assessment of potential BW microorganisms native to Africa and the Middle East. Determine disease mechanisms caused by organisms of BW significance, especially those disseminated via the airborne route. Complete evaluation in animals of potential vaccine against *Legionnaires' bacillus*; prepare report for FDA approval prior to human testing. Complete developmental studies on an inactivated Bolivian hemorrhagic fever vaccine. Complete candidate anthrax vaccine efficacy evaluation in animals and prepare technical data report. Prepare investigational new drug application for human testing for prophylaxis against this acute febrile illness. Gather and process high-titer human antiserum against potential infections or toxemias. Prepare an Investigational New Drug Application (IND) on a candidate vaccine for Ebola virus, a new agent from Africa producing severe, prostrating, febrile illness in humans. Expand studies of microbial toxins to develop safe and effective toxoids for use in combat operations. Expand studies on candidate strains for vaccines against hemorrhagic fever viruses (Lassa, Korean, and Ebola). Evaluate new methods for inactivation of viruses to produce safe vaccine products as live virus vaccines present potential problems in toxicity. Continue pharmacology studies of selected antiviral and antibacterial compounds as chemotherapeutic candidates for use in early phases of military operation. Determine effectiveness of new rapid diagnostic techniques for various infections of military importance. Evaluate reactions to infectious diseases and responses to vaccines of military importance utilizing immunological assay tests. Anticipated personnel to be utilized: 171 professional and 288 support.

4. FY 1981 Planned Program: Evaluate field test response capabilities of mobile teams including transport of "patients" and "laboratory specimens" under full-containment conditions. Develop improved procedures for detection of rickettsial agents of BW importance. Test newly developed Bolivian hemorrhagic fever vaccine in volunteers for effectiveness in preventing the disease in troops. Continue Phase I testing and begin in Phase II evaluations in humans of a candidate *chikungunya* vaccine. Conduct initial human evaluation for efficacy of a vaccine against *Legionnaires' disease*. Conduct evaluations to determine safety and efficacy in volunteers of a candidate vaccine against anthrax. Develop and test in animals or man, as appropriate, vaccines against potential BW agents. Evaluate new agents and variants of known microorganisms of BW importance as vaccine candidates. Evaluate Ebola virus vaccine in Phase I human tests to determine safety and efficacy. Advance previous preliminary efforts in toxin/toxoid program to next developmental stage of diagnosis, immunoprophylaxis, and therapy. Produce improved vaccines with

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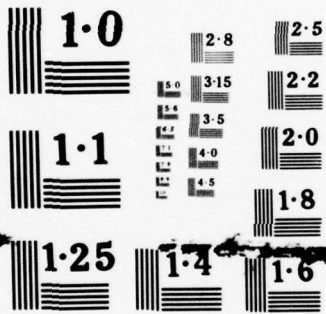
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NATIONAL BUREAU OF STANDARDS  
MICROCOPY RESOLUTION TEST CHART

Program Element: #6.27.76.A  
DoD Mission Area: #135 - Chemical Biological Warfare  
Technology Base

Title: Medical Defense Against Biological Agents  
Budget Activity: #1 - Technology Base

definitive immunologic information. Accelerate studies of immunophylaxis by enhancement of the host response to marginal antigenic stimuli. Initiate vaccine studies for Congo-Crimean hemorrhagic fever. Evaluate and apply new drugs and improved laboratory tests to determine usefulness in chemotherapeutic intervention of diagnosis of diseases with Biological Warfare (BW) potential.

5. Program to Completion: This is a continuing program.

# FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.77.A Title: Military Environmental Stress  
DoD Mission Area: #131 - Medicine and Life Sciences Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>2147</b>	<b>3000</b>	<b>6590</b>	<b>11249</b>		
A845	Military Environmental Stress	2147	3000	2797	2947	Continuing	Not Applicable
A846	Toxic Hazards of Military Environment	0	0	3793	8302	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Modern warfare exposes the soldier to extremes of heat, cold (in natural or manmade environments), to toxic by-products of combustion of exotic propellants, fuels, smokes and obscures and to extreme physical workloads. Industrial production of Army-unique chemicals (i.e., propellants and explosives - excludes chemical agents) may expose industrial workers to occupational health hazards, the nature and scope of which is unknown. To prevent degradation of performance on the battlefield and to comply with Federal law and regulation, a requirement exists to assess such health hazards, to provide a medical data base upon which reasonable standards for exposure may be based.

C. BASIS FOR FY 1980 RDTE REQUEST: Health hazard assessment of troops exposed to smokes/obscures, to toxic fumes/gases of new weapons systems (e.g., XM1 battle tank), and industrial worker exposures to toxic chemicals during munition production is vital to assure compliance with Federal Regulations (Occupational Safety and Health Administration) and provide timely medical input to materiel and weapons developers. Combat crew vehicle compartments, individual protective clothing/devices, and climatic extremes expose soldiers to severe heat and cold hazards. Military operations at high altitudes may cause large-scale incapacitation. Policy, doctrine, and future combat requirements mandate development of realistic, medically based physical fitness standards and physical training programs to ensure that human tolerance limits are not exceeded.

## D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Cost Not Applicable
	2321	4552	2925		



Program Element: #6.27.77.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Environmental Stress

Budget Activity: #1 - Technology Base

Basis for change: Decrease in funding for FY 1978 is the result of minor reprogramming to meet urgent higher priority requirements relating to jet-lag studies. Decrease in funding for FY 1979 is the result of an FY 1979 Congressional budget reduction. Increased funding for FY 1980 is the result of an early start of Project A846 for the establishment of an adequate technology data base for health hazard assessment of new military unique compounds such as smokes/obscureants, new fuels, liquid/semisolid propellants, and conventional munitions. Inability to generate seriously lagging data base may delay or prevent program manager for smokes/obscureants and other program managers from fielding their systems. Main thrust is toward hazard assessment of already identified top priority smoke/obscureant compounds. A small amount of funds for this research effort had been programmed into the FY 1979 funds of Project A845.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.77.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Environmental Stress

Budget Activity: #1 - Technology Base

**F. DETAILED BACKGROUND AND DESCRIPTION:** Health hazard assessment/prevention technology for toxic hazards of the military environment is driven by the need to train troops with smoke/obscureants, to develop safe new weapons systems, and to continue production and demilitarization of conventional munitions (propellants and high explosives). Since these militarily unique compounds pose health risks in the process of manufacture, storage, transport, handling, field use, and exposure to combustion products and contaminants, health hazard assessment prior to fielding and operational use is required to comply with Federal laws (Occupational Safety and Health Act, 1970) and with DOD requirements to establish alternate criteria for other Army-unique situations. New weapons systems require complete assessment of the crew compartment chemical environment. Workers at Army munition production facilities are exposed to compounds such as 2,4-dinitrotoluene, nitroglycerine, and trinitrotoluene suspected of causing cancer, sterility, and other irreversible health effects. Hazard assessment will allay public and regulatory agency concern and diminish costly litigation. Natural and manmade factors may expose the soldier to environmental extremes resulting in performance degradation and medical incapacitation. Presently configured combat vehicle crew compartments and individual protective clothing ensembles may pose substantial risks of heat exhaustion and heatstroke to the user. The prospects of conducting high intensity/continuous operations in hot desert scenarios (e.g., Middle East) magnify these risks. Hazard assessment/prevention during operations in arctic environments is essential for maintaining cold weather operations capability. Simultaneous presence of multiple environmental and operational stressors (e.g., continuous operations in severely cold high altitudes) may lead to large-scale incapacitation. Medical technology for prevention and treatment of environmental casualties requires substantial improvement. Considerable manpower reduction, increased utilization of female soldiers in a wider range of functions, future battlefield requirements, and increasingly heavy physical demands on fitness and endurance have highlighted the need to establish medically based realistic physical fitness standards and physical training programs to maintain combat readiness.

**G. RELATED ACTIVITIES:** Program Element/DA Project 6.27.77.A/A845, Military Environmental Stress and Program Element/DA Project 6.27.73.A/A819, Helicopter Combat Crew and Airborne Medicine, conduct research on other than chemical hazards associated with new weapon systems. In conjunction with this program (A846), a comprehensive approach to assessment of adverse health effects exists. Program Element/DA Project 6.27.20.A/A835, Military Environmental Quality, produces health effects information directly relevant to occupational exposures to chemicals (e.g., recent findings of carcinogenicity of certain munitions compounds). Basic research in Program Element/DA Project 6.11.02.A/BS08, Military Environmental Stress, and Program Element/DA Project 6.11.02.A, Identification and Health Effects of Military Pollution, support this program (A846) by developing new short-term toxicologic tests predictive of long-term effects, thus reducing future costs of health effects assessments. Program Elements/DA Projects 6.11.02.A/BS01, 6.11.02.A/BS08, and 6.27.71.A/A804 provide support for the conduct of studies in continuous operations, jet-lag, and basic science requirements of the A845 program.

**H. WORK PERFORMED BY:** In-house research for Project A846 is conducted by US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD. In-house research for Project A845 is conducted by US Army Research Institute of Environmental Medicine, Natick, MA. Extramural contracts to IIT Research Institute, Chicago, IL, and Litton Bionetics, Rockville, MD, support Project A846.

Program Element: #6,27.77.A

DDM Mission Area: #131 - Medicine and Life Sciences

Title: Military Environmental Stress

Budget Activity: #1 - Technology Base

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Initiated physical and chemical characterizations of hexachloroethane and fog oil smokes. Initiated mammalian toxicological evaluations of hexachloroethane smoke mixture and red phosphorus. Formulated recommended changes in treatment, doctrine, equipment, and training to reduce heat and cold casualties and performance effects of temperature extremes. Developed and tested a candidate test battery to determine enlistees' physical fitness for specific jobs. Determined the physiological energy costs of physical training (PT) exercises, PT test events, and common soldiering tasks. Provided input to the Women in the Army Study Group regarding the physical fitness capabilities of women to perform specific critical tasks within various Army jobs.

2. FY 1979 Program: Complete physical/chemical characterizations of hexachloroethane and fog oil smokes. Continue mammalian toxicological evaluations of hexachloroethane smoke mixture and red phosphorus. Start inhalation toxicological studies of red phosphorus smoke. Start chemical characterizations of XM-1 tank interior. Conduct Problem Definition Study of contaminants found in XM-1 tank interior. Conduct feasibility study for epidemiology of munition plant occupational exposures. Develop models for laboratory simulation of performance decrement under conditions of high terrestrial altitude, heat, and cold. Develop technologies for reduction or mitigation of heat stress in armored combat vehicles. Refine techniques for predicting military environmental casualties in order to anticipate and prevent decrements in performance. Establish physical fitness standards for sedentary Army jobs and recommend improvements in physical training programs to meet those standards. Determine sex differences in physical training requirements, with emphasis on prevention of training injuries. Develop improved methodology for assessment of physical fitness suitable for predicting job performance. Assess effects of rapid translocation on physical work capabilities.

3. FY 1980 Planned Program: Continue mammalian toxicological evaluation of hexachloroethane smoke mixture and red phosphorus. Continue inhalation studies of red phosphorus smoke. Start toxicological studies on white phosphorus wedge smoke. Start diesel fuel toxicological studies. Start acute and subchronic studies on XM-1 tank interior contaminants. Conduct Problem Definition Study on potential occupational hazards from conventional munitions demilitarization. Start retrospective epidemiological studies for munition plant exposures. Conduct Problem Definition Study on new smoke/obscurant munition candidates. Conduct a study of combined stressors, including continuous operations, with field artillery teams. Prepare guidance for field commanders concerning operations at high terrestrial altitudes. Define physiologic and performance effects of combined environmental stressors, to include the combat vehicle environment. Develop biomedical design criteria for new-generation combat clothing. Validate and refine physical fitness standards and training programs for sedentary Army jobs. Establish specific physical fitness standards for jobs with intermediate physical fitness requirements. Recommend improvements in physical training programs to meet fitness standards. Develop recommendations to optimize physical training of female soldiers. Develop improved parameters for job-specific measurement of physical fitness. Validate initial assessment of rapid translocation effects on physical work capacity. Approximately 166 personnel will be utilized for this program; professional 65, support 101.



Program Element: #6.27.77.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Military Environmental Stress

Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: Continue mammalian toxicological evaluation of hexachloroethane smoke mixture and red phosphorus. Continue inhalation studies of red phosphorus smoke munition. Continue toxicological studies on white phosphorus wedge smoke. Continue toxicological studies on diesel fuel. Start toxicological studies on new smoke/obscurant candidates. Complete retrospective epidemiological studies for munition plant exposures. Continue toxicological studies on conventional munitions demilitarization contaminants. Continue toxicological studies on XM-1 tank interior contaminants. Assess the performance of personnel protective clothing and equipment in the course of operational performance. Perform applied laboratory and field experiments on the physiologic and environmental impact of military operations on combat crew effectiveness. Develop physical fitness standards for jobs with strenuous physical requirements. Validate and refine standards for intermediate jobs. Validate recommendations for improving training of women soldiers. Validate improved methodology and measures for physical fitness assessment. Develop measures to offset the adverse effects of rapid translocation on physical work capacity.

5. Program to Completion: This is a continuing program.

FY 1980 RDTF CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.78.A  
DoD Mission Area: #131 - Medicine and Life Sciences  
Title: Combat Medical Materiel  
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
	<u>TOTAL FOR PROGRAM ELEMENT</u>	<u>843</u>	<u>1531</u>	<u>998</u>	<u>1048</u>		
A838	Combat Medical Materiel	843	1531	998	1048	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Program required to develop medical equipment to support the health care delivery system in the field under combat conditions. Development of new and improved medical field equipment is essential to: (1) provide quality medical care to the soldier in the field; (2) reduce the problems and complexity of diagnosis and treatment of large numbers of devastating combat injuries associated with the need for tactical flexibility in modern warfare and new weapons development; (3) maintain a reliable and efficient casualty treatment and evacuation system; and (4) provide the degree of medical support equipment to enable deployed forces to realize the maximum capabilities from the highly sophisticated weaponry now being fielded.

C. BASIS FOR FY 1980 RDTF REQUEST: Requests promoted necessary growth in the level of effort to insure accomplishment of project objectives; namely research insures advancement and improvement in field medical equipment/treatment. Also supports anticipated tasking in the form of Letter of Agreement by the Academy of Health Sciences, US Army, and concurred in by The Surgeon General.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTF	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
Funds (as shown in FY 1979 submission)	1402	1531	1628	Continuing	Not Applicable

Change in FY78 program due to reprogramming actions in support of technological effort in vaccine production base. Decrease in FY 1980 funds is due to refined estimates of costs to support the FY 1980 planned program.

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.78.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Combat Medical Materiel

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: A reliable and efficient casualty treatment system during wartime is essential to maintain combat strength. Doctrine for modern warfare and new weapon developments increased the problem and complexity of diagnosing and treating large numbers of combat injuries. The objective of this program element is to develop medical, dental, veterinary, and pest management equipment required to support the health care delivery system in the field. The approach is through feasibility studies, design, fabrication and testing of experimental prototypes. These efforts provide the basis for determining technical feasibility and cost of required advanced development and/or engineering development.

G. RELATED ACTIVITIES: Related research, development, test and evaluation is conducted under Program Element 6.37.32.A, Combat Medical Materiel, and 6.47.17.A, Combat Medical Materiel. Army programs are closely coordinated with Air Force and Navy medical materiel development programs via formal symposiums and informal contacts to insure that there is no duplication.

H. WORK PERFORMED BY: Sixty percent of the work is performed in-house at the US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD. Forty percent to be performed under extramural contracts. Contractors presently not identified. Total contract funding is \$400,000.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Developed training device, antidote nerve agent, auto-injector; designed heater liner for evacuation bag; completed phase II of sterilization study in preparation and processing of medical supplies in the field; adopted a portable low capacity X-ray scanner; designed and fabricated new portable dental operating chair; evaluated Norwegian shelter for potential medical use; redesigned and developed new cabinets for Must Combat Support Hospital; completed field test on clinical prototype instrument for objective and automated measurements of visual acuity; initiated development on a micro-dose radiographic scanner; a helicopter-slung solid pesticide dispersal unit underwent feasibility testing; completed design of the light trap, portable, AC/DC-powered; and completed development and evaluation of a concentrator mosquito larvae.

2. FY 1979 Program: Development initiated of personnel/patient decontamination site to meet Army needs. Design and fabricate a new medical set aidman bag. Contracts to be awarded to steam vacuum pulsed and ethylene oxide sterilizers. Initiate development of a high capacity X-ray system. Establish requirements documentation for materiel needs for operation and field medical support in a chemical environment. Develop amyl nitrite ampule training device. Conduct studies on technical feasibility on medical equipment complaints generated from the field. Define functional parameters and alternative equipment based upon a recognized requirement for a reliable and rugged system for clinical analysis of body fluids within Army field medical facilities. Evaluate clinical prototype on a diagnostic X-ray system. Analyze commercial X-ray film processors and/or develop a processor to complement a portable low capacity X-ray system. Initiate development of an integrated pest management program for blackflies. Continue engineering design and durability testing of commercial pest management equipment. Conduct feasibility study on tactical ambulance adaptation.



Program Element: #6.27.78.A

DoD Mission Area: #131 - Medicine and Life Sciences

Title: Combat Medical Materiel

Budget Activity: #1 - Technology Base

3. FY 1980 Planned Program: Design a modern utility unit to provide field dental personnel with a self-contained pressurized water supply and evacuation system. Field test the X-ray film processor. Continue development, evaluation, and testing of a high capacity X-ray system. Continue development of a clinical analysis system for field use. Update and modernize the dental operating, hygienist, and prosthodontic sets to provide an increase in combat readiness and reliability. Evaluate and operationally test steam vacuum pulsed and ethylene oxide sterilizers. Design, fabricate, or obtain a lightweight field sterilizer capable of being used in the field by special forces or in field dental activities. Field test new medical set aidman's bag. Evaluate and test personnel/patient decontamination sets. Continue exploratory development on casualty decontamination equipment. Initiate development of an integrated pest management program for mosquitoes. Complete operational testing of helicopter-slung liquid pesticide dispersal unit. Personnel to be utilized are 20 professional personnel and 23 support personnel.
4. FY 1981 Planned Program: Design a respiratory for use in a chemical environment. Move steam vacuum pulsed and ethylene oxide sterilizers to advanced engineering development. Develop modular cabinetry for a family of dental operating sets. Continue development of medical, dental, and pest management materiel necessary for maintenance of a combat force engaged in general and limited warfare as well as special requirements related to desert, cold weather, mountain, airborne, night operations, and operations in built-up areas. Accomplish developmental testing of integrated pest management program for blackflies and mosquitoes. Complete development testing of the pesticide dispersal unit calibration set and incorporation of pesticide into camouflage paint.
5. Program to Completion: This is a continuing program.

# FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.79.A

DoD Mission Area: #154 Mobility and Logistic Technology

Title: Test, Measurement, and Diagnostic Equipment Technology

Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
<b>TOTAL FOR PROGRAM ELEMENT</b>							
AN62	Test, Measurement, and Diagnostic Technology	921	0	700	2257	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** Develops new testing techniques, design methodologies and equipments in order to reduce the amount of test equipment and skills required at all levels of maintenance. The new Test Measurement Diagnostic Equipment (TMDE) being developed will provide a more effective means of diagnosis of defective equipment, modules, and parts and concurrently reduce diagnostic time and manpower requirements. Major effort will be directed toward eliminating proliferation resulting from single application test equipment. The ultimate benefits derived from this program will be greater reliability, availability, and maintainability (RAM) of prime Army systems and significant cost savings from upgraded logistic support.

**C. BASIS FOR FY 1980 RDT&E REQUEST:** Initiate development of lightweight, simplified tactical test equipment to provide a cost effective operational test capability at organizational levels. Continue to develop and demonstrate the feasibility of cost effective built-in test for computers/microprocessors in prototype systems. Hardware and software techniques will be developed and modeling techniques will be used to determine their effectiveness.

## D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDT&E Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Cost
	505	435	700	Continuing	Not Applicable

Due to Congressional cut in FY 1979 funds, no new efforts were begun in FY 1979. Increase in FY 1978 funds were used to prepare systems specifications for a family of suitcase testers and to demonstrate the feasibility of providing Built-In-Test capability for microprocessors.

## E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.79.A

Title: Test, Measurement, and Diagnostic Equipment Technology

DoD Mission Area: #154 - Mobility and Logistic Technology

Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The test measurement and diagnostic equipment technology program will develop new testing techniques and equipments which will reduce the amount of test equipment and skills required at all levels of maintenance. Major effort is directed toward the elimination of the need for most single application test equipment. New test, measurement, and diagnostic equipment will provide the Army with the capability to diagnose faults and isolate them without equipment tear-down. The test, measurement, and diagnostic equipment being developed will detect equipment defects more efficiently and with greater accuracy.

G. RELATED ACTIVITIES: Program Element 6.37.09.A (Advanced Technology for Test Measurement Diagnostic Equipment (TMDE)) and 6.37.48.A (Automatic Test Equipment) and 6.47.46.A (Automatic Test Support Systems) provide the Advanced and Engineering Development, respectively for work started in this program.

H. WORK PERFORMED BY: The in-house and contract monitoring work is performed by the US Army Communications Research and Development Command, Fort Monmouth, NJ. Contractors participating in the program include: Applied Technology Incorporated, Sunnyvale, CA; Emerson Electric Company, Saint Louis, MO; Research Triangle Institute, Research Triangle Park, Durham, NC.

#### 1. PROGRAM ACCOMPLISHMENT AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Completed the systems definition phase of a modularized microprocessor-controlled test system (known as CARTE) to meet future requirements for Direct Support/Organizational areas screening and equipment repair. Evaluated digital control bus architecture and prepared systems specification in support of a Direct Support/Organizational family of suitcase testers to be developed by Project Manager, Automatic Test Support System. Provided test programming sets (TPS), cost algorithms and design guides to assist in planning and specifying TPS requirements at minimum cost. Initiated studies to improve the testability of Large Scale Integration (LSI) printed circuit card modules and development of computerized methodologies for assessment of built-in test for system and module levels. Developed and revised military standard (MIL-STD-1462A) for an improved test programming language for future Department of Defense (DOD)/Industry Automatic Test Equipment (ATE) systems.

2. FY 1979 Program: Due to a Congressional cut in FY 1979 funds no new work will be undertaken except to prepare for the FY 1980 planned program and to maintain overall program direction.

3. FY 1980 Planned Program: Complete the contractual programs to develop a Built-In Test (BIT) technology base and demonstrate the feasibility of cost effective built-in test for computer/microprocessors in prototype computer embedded systems applications. Develop a "Figure of Merit" to assess various competitive design approaches for testability. Advanced signal analysis and measurement techniques will be developed to expand the capability of future automatic test equipment systems. Participate in the Joint Logistics Commanders (JLC) Panel on Automatic Testing in the assigned areas of testing technology. Five professional and five support personnel will support these efforts.



Program Element: #6.27.79.A

DoD Mission Area: #154 - Mobility and Logistic Technology

Title: Test, Measurement, and Diagnostic Equipment Technology  
Budget Activity: #1 - Technology Base

4. FY 1981 Planned Program: Lightweight, low power, rugged, portable Test Measurement Diagnostic Equipment (TMDE) will be designed to provide forward area operation support to the Army's tactical systems. Continue development for automatic test program generation and fault analysis techniques to reduce the number of manhours and dollars required to develop such test programs for Automatic Test Equipment (ATE). Initiate efforts for the investigation of advanced high speed data bus architecture in order to cope with the future very high speed integrated circuits (VHSI) under development and the wide band communications systems utilizing fiber optic technology.

5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.80.A  
 DoD Mission Area: #135 - Chemical Biological Warfare  
 Title: Medical Systems in Chemical Defense  
 Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate 1800	FY 1980 Estimate 1890	FY 1981 Estimate 1969	Additional to Completion Continuing	Total Estimated Costs Not Applicable
TOTAL FOR PROGRAM ELEMENT							
A843	Medical Systems in Chemical Defense	0	1800	1890	1969	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Objectives of this program are directed toward the development of: (1) medical systems for prevention and therapy of combined chemical warfare (CW/conventional injuries; and (2) a rapid casualty evaluation system. The threat of nuclear weapons requires development of means for treatment of prophylaxis against the effects of ionizing radiation.

C. BASIS FOR FY 1980 RDTE REQUEST: Funds requested will provide for the investigation of systems for medical casualties having combined chemical/radiation/conventional injuries, and the development of a casualty decontamination system.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
Funds (as shown in FY 1979 submission)	0	1800	3600	Continuing	Not Applicable

Decrease in FY80 funds is due to redefinition of program within minimum funding level guidance.

Program Element: #6.27.80.A

DoD Mission Area: #135 - Chemical Biological Warfare  
Technology Base

Title: Medical Systems in Chemical Defense  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: Program initiated in FY 1979 with objectives to minimize troop vulnerability by providing means for collective prevention and collective therapy of multiple agents with a compound effort, and to develop medical systems to employ these means to protect, treat, and evaluate casualties resulting from exposure to a broad range of chemical warfare agents at each echelon of medical treatment. This program is essential to minimize chemical casualties and return those casualties to duty as rapidly as possible, thus reducing the drain on combat resources.

G. RELATED ACTIVITIES: Work under Program Element 6.24.34.A, Medical Defense Against Chemical Agents, focuses on individual rather than collective prevention and therapy. The two projects are closely coordinated. Related Army, Navy, and Air Force programs, with Army as the executive agency, are coordinated to insure no duplication of effort.

H. WORK PERFORMED BY: Research is performed in-house at the Walter Reed Army Institute of Research, Washington, DC.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Not Applicable.

2. FY 1979 Program: Evaluation of the state-of-the-art in prevention/treatment of chemical casualties and treatment of radiation casualties begun. Development of a casualty decontamination system allowing rapid decontamination with minimum personnel resources initiated. Develop technology for a casualty evaluation system. Perform preclinical testing of dimercaprol ophthalmic ointment for use in mustard/lewisite treatment. Develop systems for medical treatment of casualties which have a combined chemical and traumatic injury. Explore means for soldier protection against the effects of ionizing radiation. Ionizing radiation research will focus on recent state-of-the-art advances in drug formulation and development which indicate the potential for antiradiation chemoprophylaxis.

3. FY 1980 Planned Program: Continue development (year 2) of a rapid, field decontamination system. Complete preclinical testing of dimercaprol ophthalmic ointment for use in mustard treatment. Continue focus on design of medical systems responsive to casualties with combined chemical and conventional injury. Continue reformulation of promising drugs to determine their potential for antiradiation chemoprophylaxis. Personnel to be utilized: 34 professional, 14 support.

4. FY 1981 Planned Program: Continue examination of casualty decontamination systems, combined injury, and skin protective agents. Initiate efforts to design a respiratory resuscitative system for large numbers of casualties.

5. Program to Completion: This is a continuing program.



# FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.01.A Title: Military Energy Technology  
DoD Mission Area: #153 - Military Engineering Technology Base Budget Activity: #1 - Technology Base

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Cost Not Applicable
AT45	Military Energy Technology	0	0	2635	2956	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program is oriented to take full advantage of new energy technology advanced by Department of Energy and the civil sector for applications at Army installations in achieving the President's energy goals of reducing energy consumption in existing Federal facilities by 20% and in new facilities by 40% by 1985. The program focus is to provide guidance and criteria for the selection of the most effective energy conservation measures, to examine the potential of alternative energy sources that will replace fossil fuels at remote military facilities or in areas of high fuel cost, to increase energy independence and management of energy resources on Army installations, and to minimize the effect of energy shortages and high costs on the military facilities and the Army mission. Resources saved by reducing operating energy costs can be utilized to support Army combat related work.

C. BASIS FOR FY 1980 RDTE REQUEST: This program is essential to provide means to characterize and reduce energy use on Army installations, and to establish a data base for analysis and improved management of energy resources. Research in energy conservation is needed to adapt to Army needs, technology developed by others or to develop technology if absolutely necessary for Army operations, for inexpensive easily used techniques to analyze facility energy consumption and evaluate conservation alternatives. These tools are essential for: (1) rational formulation of future energy goals; (2) analysis and evaluation of alternative strategies for the Army's energy conservation investment programs; and (3) establishing priorities for retrofits and proposed new construction to meet current goals. Research in alternative energy sources will be directed to solar energy applications mandated by Congress in the Military Construction Program and evaluations of the use of coal technology as a primary energy source at military facilities in order to permit conversion from oil and gas sources as primary fuels in central energy plants. Major objectives include the establishment of standards for energy use in installations and buildings; performance evaluation and acceptance test criteria for solar energy heating and cooling systems to procure effective and efficient solar systems; criteria and techniques for cost effective conversions to coal at military facilities; and development of criteria specifications for compact inexpensive automated energy control systems.

Program Element: #6.27.81.A  
DoD Mission Area: #153 - Military Engineering Technology Base

Title: Military Energy Technology  
Budget Activity: #1 - Technology Base

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Total	
				Additional to Completion	Estimated Cost
	0	2200	2000	Continuing	Not Applicable

FY 1979 project funding of \$2.2 million was deleted from military appropriations bill by Joint Appropriations Committee action in the 95th Congress. Increase of \$635K in FY80 provides funding to support technology gaps that impact achieving energy goals.

E. OTHER APPROPRIATIONS FUNDS: Not Applicable

Program Element: #6.27.81.A  
DoD Mission Area: #153

Military Engineering Technology Base

Title: Military Energy Technology  
Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: This research project addresses requirements to reduce energy consumption and minimize the impact on Army operations of the increasing cost of fuel and decreasing availability of petroleum products. The prime thrust is to evaluate technology being developed by the Department of Energy and the civilian sector and adapt applicable technology to Army use by assuring that performance and procurement specifications are technically sound and cost effective. This includes a development of analytical methods and management techniques to provide the facility engineers, installation commanders and the Department of the Army with techniques and methods to assess energy alternatives and develop long-range plans; to assist in determining policy, establish requirements, set realistic goals and determine investment priorities for energy sources considering availability, cost and energy use in the Army.

G. RELATED ACTIVITIES: The energy technology program was formerly a technical area in Program Element 6.27.31.A, Project AT41, Military Facilities Engineering Technology. This program is coordinated on an inter-service basis with both the Navy and Air Force through the activities of the Interagency Power Group, Joint Services Civil Engineering Research and Development Coordinating Group and the Tri-Service Energy Control System Specification Working Group. Joint programs with the U.S. Air Force include the energy audit program and the development of the Building Loads Analysis and Systems Thermodynamics (BLAST) program. Related projects are Projects AT23 - Basic Research in Military Construction; Army Engineer Construction Engineering Research Laboratory, Champaign, IL and Project AT41 - Military Facilities Engineering Technology - Army Engineer Construction Engineering Research Laboratory, Champaign, IL. Under a joint DOE/DOD energy initiatives program, the Army has been assigned Lead Responsibility for coordinating DOD energy activities in solar heating and cooling, computer programs to determine energy characteristics of buildings, wood fired boilers, energy storage and distribution, energy conservation, advanced heating and air conditioning systems and advanced low-head hydropower. The Army and DOE are conducting a joint pilot plant operation for using refuse as an energy source at the Pentagon.

H. WORK PERFORMED BY: Approximately 65% of project funds will be used for in-house effort at the Army Engineer Construction Engineering Research Laboratory with participation by the Facility Engineer Support Agency, Ft. Belvoir, VA and Army Engineer Cold Regions Research and Engineering Laboratory, Hanover, NH. Contractors for the FY 1980 RDIE program have not been identified.

1. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Not Applicable.

2. FY 1979 Program: Not Applicable.

3. FY 1980 Planned Program: Research activities addressed in energy conservation methods and techniques include: (1) The development of a design guide to use the Building Loads Analysis and System Thermodynamics (BLAST) program computer-aided cost estimating system in new building design; (2) and analysis and assessment of energy consumption in Army facilities derived from analysis of data collected under the Fixed Facility Energy Consumption Investigation (FFECI); (3) plans and methods of reducing the growing use of electrical energy at military installations. Activities planned on the alternate energy sources area include: (1) the development of an engineering guide for the handling, combustion properties and disposal of byproducts associated with the use



Program Element: #6.27.81.A  
DoD Mission Area: #153 - Military Engineering Technology Base

Title: Military Energy Technology  
Budget Activity: #1 - Technology Base

of refuse derived fuel; (2) using solar energy system performance data to complete development of design procedures for solar energy systems to be used at military installations; and (3) completing the engineering instructions on coal conversion design details and cost estimating guidance for converting Army central heating power plants to coal. In the energy management and control area, research activities planned include: (1) completion of the development of an energy control system selection guidance for use in determining the technical and economic feasibility of automated energy control systems; (2) completion of development of acceptance testing procedures for new systems using energy monitoring and control systems; and (3) standard operating software for microprocessor-based energy monitoring and control of heating, ventilating and air conditioning systems. The FY 1980 research program will involve 26 professional and 12 support personnel for the in-house effort and contract monitoring.

4. FY 1981 Planned Program: Planned research activities for energy will include: (1) the development of criteria for energy storage distribution systems and (2) energy consumption data and energy profiles for Army facilities for use in the selection of energy conservation techniques. Research in alternate energy sources will include: (1) the development of operation and maintenance procedures for solar heating and cooling systems used in military construction. In energy management and control, activities will include: (1) completion of operation and maintenance procedures for energy monitoring and control systems and (2) the development of alternative strategies and management techniques to improve energy conservation at military facilities.

5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.82.A

DOD Mission Area: #121 - Electron Devices

Title: Very High Speed Integrated Circuits

Budget Activity: #1 - Technology Base

TO BE SUBMITTED UNDER SEPARATE COVER

FY 1980 RDT CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.31.02.A

DoD Mission Area: #241 - Materials and Structures

Title: Materials Scale-Up

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

A. RESOURCES (PROJECT LISTING): FY 1978 THROUGH FY 1981							
Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total
							Estimated Costs
TOTAL FOR PROGRAM ELEMENT							Not Applicable
D071	Materials Scale-Up/Structures Demonstration	1547	2026	3300	6450	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** The work under this program is non-system advanced development for the scale-up, evaluation and demonstration of new and advanced materials for components and structures of Army weapon systems. The objective is to fully characterize scaled-up materials to the extent necessary to permit confident, reliable, and cost effective use by Army weapon system design engineers. Army mission need is reflected in requirements for materials to meet increasing demands for faster, stronger, lighter, more reliable, more maintainable, and cheaper weapon systems. New and advanced materials, when developed, lack the levels of characterization, demonstrated reliability, maintainability, and cost effectiveness necessary for confident use in new weapon systems and for product improvement of weapon systems in inventory. Lack of scaled-up demonstrated performance and demonstrated cost effectiveness of new materials causes use of outdated materials for the increasingly demanding requirements of advanced weapon systems with resultant costly overdesign, costly and sometimes catastrophic weapon failures, and frequently unacceptable levels of cost over-runs in development. Specific mission need is reflected in unacceptable levels of reproducibility in ballistics performance of current high density penetrator munitions due to insufficient characterization of core materials; limitations of span length and stiffness of current mobile bridging structures due to absence of the necessary performance evaluation and characterization of advanced composites bridging materials; unacceptable levels of lethality suffered by ground combat vehicle crews and personnel due to need for full evaluation and demonstration of composite crew compartment liner materials assemblies to defeat wide angle back-face spall generated by antiarmor munitions; and high maintenance/operations costs of advanced helicopter drive-train systems components due to unavailability of demonstrated high strength modulus - lightweight materials.

**C. BASIS FOR FY 1980 RDT REQUEST:** New major thrust will be initiated for scale-up evaluations and demonstration of metal-matrix composites for longer life helicopter drive train components. Programs will be continued to scale-up, evaluate and fully demonstrate performance, reliability, maintainability, and cost effectiveness of advanced gear, bearing, drive shaft, and transmission reinforcement materials for the Army CH-47 helicopter drive train systems and of powdered metals compositions and alloys for cores of advanced high density penetrator munitions. Programs will also be continued to evaluate and demonstrate effectiveness of scaled-up components for portable lightweight bridging and of spall suppression liner materials combinations for ground combat vehicles. Work will be continued to evaluate and demonstrate coatings and coating techniques for lining gun barrels to significantly reduce erosion problems and extend gun tube life.



Program Element: #6.31.02.A

DoD Mission Area: #241 - Materials and Structures

Title: Materials Scale-Up

Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Not Applicable
	2382	2026	3300	Continuing		

The decrease in FY 1978 is due to adjustments to provide funding for higher priority requirements.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.31.02.A

DoD Mission Area: #241 - Materials and Structures

Title: Materials Scale-Up

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: Knowledge is being continually produced through exploratory development of new materials, new materials specifications and characterization of new materials in specimen configurations. A critical gap exists between the knowledge of these new materials in specimen configurations and the knowledge required for use of advanced material in engineering development of Army weapon systems. This program, designed to fill that gap, was initiated in FY 1976 with the objective of fully characterizing advanced materials in geometric shapes used in Army systems to avoid cost overruns in engineering development; prove superiority of advanced material by competitive evaluation to avoid poor materials choices in weapon system development; fabricate scaled prototypes from advanced materials to minimize scaled-up surprises; and to demonstrate cost effectiveness of advanced materials hardware to minimize cost overruns. Deficiency in knowledge of scaling factors of superior high strength properties of metal-matrix composites prevents near-term application in advanced Army weapon systems.

G. RELATED ACTIVITIES: The Air Force, Navy, other Government agencies and allied nations have analogous programs. Although similar in approach, these programs differ greatly in emphasis placed on materials advanced development for specific hardware applications. Coordination within the Department of Defense is achieved through meetings of the Office of the Deputy Under Secretary for Defense Research and Engineering's ad hoc Services Materials Laboratories Council. Coordination with the non-military federal agencies is effected through participation in activities of the National Materials Advisory Board of the National Academy of Sciences--National Academy of Engineering, and the Federal Council on Science and Technology - Committee on Materials. International coordination is effected through participation in the Technical Cooperation Program with Australia, Canada, New Zealand and the United Kingdom and the Structures and Materials Panel of the Advisory Group for Aerospace Research and Development of the North Atlantic Treaty Organization.

H. WORK PERFORMED BY: In FY 1980, it is planned that approximately 60 percent of the work be accomplished in-house at the US Army Materials and Mechanics Research Center, Watertown, MA; US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; and the Army Armament Research and Development Command, Dover, NJ; and the Army Aviation Research and Development Command, Fort Eustis, VA. Typical contractors are GTE/Sylvania, Towanda, PA; FMC Corporation, San Jose, CA; Fiber Materials, Inc., Biddeford, ME; and the Boeing Aircraft Co., Philadelphia, PA.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Lightweight, high strength structural foam components have been fabricated and scaled-up for low-cost ammunition pallets, tank track shoes, and for the stabilization element of remotely piloted vehicles. Specifications were determined for core materials composition and for processing and fabrication procedures in the scaled-up state for high density penetrator munitions. Current portable bridging structures have span length and stiffness limitations imposed by the load capability of the transport/retrieval vehicle. Work was carried out to scale-up and stiffen reinforced plastic structures thereby increasing span length without increasing weight. Scaled-up bridge members and attachment components were designed and fabricated by the pultrusion processing method. Severe behind-the-armor effects within combat vehicles caused by impact by kinetic energy and other projectiles generate increased casualties and damage to critical components. To protect against this damage, scaled-up composite spall suppression liners were fabricated and evaluated. Advanced materials were scaled-up as components to reduce wear/vibration in helicopter drive train systems.

Program Element: #6.11.02.A  
Sub Mission Area: #241 - Materials and Structures

Title: Materials Scale-Up  
Budget Activity: #2 - Advanced Technology Development

2. FY 1979 Program: Existing high density penetrator materials are deficient in reproducibility and are costly. Specifications are being determined for core materials composition and for processing and fabricating procedures in the scaled-up state. Current portable bridging structures have span length and stiffness limitations imposed by the load capacity of the transport/retrieval vehicle. Work is continuing to scale-up and stiffen composite structures thereby increasing span length without increasing weight. Prototype bridge members and attachment components are being designed and fabricated. Severe behind-the-armor effects within combat vehicles caused by kinetic energy and other projectiles generate increased casualties and damage to critical components. Scaled-up composite spall suppression liners in conjunction with aluminum armor are being evaluated for protection against high energy fragmentation and penetrator munitions threats. Subscale transmission housing component test results are being evaluated and design analyses performed to reduce vibration in helicopter drive systems.

3. FY 1980 Planned Program: The programs conducted in FY 1979 will be continued to complete the work on spall suppression liners and advance the work on lightweight, high strength composite bridging components. Results obtained during FY 1979 will be used to develop a cost-effective short cycle heat treatment procedure to impart improved mechanical properties to large caliber armor penetrators with elimination of residual stresses that cause failures. Metal matrix composite CII-47 transmission case components will be fabricated and evaluated under simulated flight conditions. The objective of the new major thrust is reduction of wear/vibration and reduced time between overhaul of drive systems expected to generate life time cost reduction of the order of 42 percent. There will be 125 professionals and 175 support personnel involved in these efforts.

4. FY 1981 Planned Program: Full-scale lightweight composite bridging components will be fabricated and evaluated. Full scale testing will be initiated on metal matrix composite helicopter transmission housing components by installing in the aircraft and performing ground tests. A major scale-up armor materials development program will be initiated in innovative approaches, including appliques of armor, for demonstration and evaluation to reduce the vulnerability of current armored vehicles to the high density penetrator munitions. Fragmenting munitions materials to enhance handling and launch reliability and safety will be scaled up and evaluated. Work will be initiated on scale-up and evaluation of erosion-resistant linings and coatings for large caliber gun tubes. There will be 27 professionals and 29 support personnel involved in these efforts.

5. Program to Completion: This is a continuing program.



FY 1980 RUTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.31.04.A

DoD Mission Area: #244 - Mobility & Logistics Technology  
Demonstration

Title: Fuels & Equipment

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total	
							Estimated Costs	Not Applicable
	<u>TOTAL FOR PROGRAM</u>	0	0	600	1580	Continuing	Not Applicable	
D150	Fuels and Equipment	0	0	600	1580	Continuing	Not Applicable	

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army's current RTE program is lacking in the capability to conduct advanced development of component subsystem necessary for use of new fuels and lubricants and capability to execute field/user evaluation and testing prior to issuing new products. Purpose of program is to conduct, necessary advanced development for new fuels, fluids and subsystems and to conduct field user evaluation.

C. BASIS FOR FY 1980 RTE REQUEST: Advanced development and evaluation of low vulnerability fuel that will significantly increase survivability of ground combat vehicles because of fuel system fires. Initiate advanced development of total system for mixing, handling and storage of low vulnerability fuel for use in combat environments.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands): Not Applicable.  
New start in FY80.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.31.04.A

DOD Mission Area: #244 - Mobility & Logistics Technology  
Demonstration

Title: Fuels & Equipment

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: This program covers those efforts directed towards overcoming obstacles to mobility and increased survivability of ground combat vehicles caused by present low probability of survivability of crews and costly damage to vehicles beyond the point of salvage due to fuel system fires of ground combat vehicles. Multiple lethal effects of intense heat, exploding ammunition and disabling atmospheric environment are the threats that must be overcome. The objective of this project is to develop a Low-Vulnerability Fire-Safe Fuel that will significantly increase the survivability of combat vehicles. The approach taken is to optimize an emulsion of diesel fuel, water, emulsifiers, and antimist additives to achieve the required properties. Laboratory and fleet tests will be performed to insure compatibility with the appropriate Army ground combat vehicles. A field mixing unit and modified pumping/filtration equipment will be developed to prepare and handle the fuel.

G. RELATED ACTIVITIES: In the fuels and lubricants technical area, active liaison and coordination is maintained with other Services, the Environmental Protection Agency, Federal Aviation Administration and Department of Energy.

H. WORK PERFORMED BY: In-house work by US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, and the US Army Fuels and Lubricants Research Laboratory, Southwest Research Institute, San Antonio, TX.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Not Applicable. New start in FY80.
2. FY 1979 Program: Not Applicable. New start in FY80.
3. FY 1980 Planned Program: Advanced development and evaluation of a low-vulnerability fuel that will significantly increase survivability of ground combat vehicles to fuel systems fires. Initiate advanced development of total system for mixing, handling and storage of low-vulnerability fuel for use in combat environments. There will be 15 professionals and 18 support personnel involved in these efforts.
4. FY 1981 Planned Program: Conduct fleet test of mixed vehicles. Determine effects of fire-safe fuel on engine performance and durability. Procure field mixing units for tests and evaluation. Prepare sufficient quantities of fire-safe fuels to establish quality assurance requirements and investigate extent of field testing required for this fuel. Procure for tests and evaluation filters and pumps needed for transfer and dispensing fire-safe fuel for fleet test. There will be 21 professionals and 27 support personnel involved in these efforts.
5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.01.A

Title: Aircraft Power Plants and Propulsion

DoD Mission Area: #233 - Aircraft Propulsion Technology

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
DB72	Propulsion Components		162	0	0	1085	Continuing	Not Applicable
DA47	Demonstrator Engines		2905	7000	8300	5000	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The program objective is to demonstrate the integration and performance potential of advanced turbomachinery components and of drive train technology through tests of engines and transmissions. This advanced engine and transmission technology is available for use in advanced air mobility systems and provides for reductions in fuel consumption, weight, maintenance requirements, vulnerable area, production cost, and reductions in lead time for development.

C. BASIS FOR FY 1980 RDTE REQUEST: Contracts were awarded in February 1977 for the development, fabrication, and testing of two 800 shaft horsepower (SHP) Advanced Technology Demonstrator Engine (ATDE) designs. These contracts represent virtually all of the program funding. Essentially all testing will be completed in FY 1980 to validate technology improvements to provide 20 percent reduction in fuel consumption, 50 percent reduction in vulnerable area, and 25 to 35 percent increase in specific power (SHP per pound of airflow).

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE	Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Costs
		3067	7000	10905	Continuing	Not Applicable

Reduction in FY 1980 funds is due to funds being shifted to higher priority work.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.32.01.A Title: Aircraft Power Plants and Propulsion  
DoD Mission Area: F233 - Aircraft Propulsion Technology Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to demonstrate the integration and potential of advanced turbomachinery components and drive train technology through full-scale tests of engines and transmissions. The program provides for design, fabrication, and testing of advanced propulsion systems. In recent years the need for improvements in technology has become more pronounced, not only in the areas of vehicle performance, but also in areas of cost, reliability, maintainability, safety, and survivability. Advanced component technology from Army exploratory development and other Government and industry-sponsored programs will be applied to advanced gas generators, engines, and drive trains in demonstration and validation tests. Primary emphasis will be placed on those areas that will benefit near-term aircraft development programs. Complete engine subsystems are integrated and tested under the Advanced Technology Demonstrator Engine (ATDE) program. The Helicopter Advanced Drive Train (HADT) program will provide the systems approach for a multidisciplinary effort and place drive train technology on a par with the many advances made in aircraft turbine engines.

G. RELATED ACTIVITIES: Mutual exchanges of information occur with the United States Air Force, the United States Navy, and National Aeronautics and Space Administration. Agencies are advised of program progress by semiannual meetings, a Tri-Service Aircraft Propulsion Technology Coordinating Paper, an Informal Tri-Service Coordination Group, and visits to industry. Related Program Elements are 6.11.02, Air Mobility; 6.22.09.A, Aeronautical Technology; and 6.42.06, Utility Tactical Transport Aircraft System (T700 Engine Project).

H. WORK PERFORMED BY: Detroit Diesel Allison Division, General Motors Corporation, Indianapolis, IN; and AVCO Lycoming Division, Stratford, CT. The program is the responsibility of the Applied Technology Laboratory of the US Army Research and Technology Laboratories, US Army Aviation Research and Development Command, Fort Eustis, VA.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Two successful efforts that have been completed were the 1500 shaft horsepower (SHP) Demonstrator Engine program and the Small Turbine Advanced Gas Generator (STAGG) program. The 1500 SHP Demonstrator Engine program identified the capabilities and limitations of an engine in that size class and has since transitioned through full engineering development as the T700 engine which is the power plant for the Army's UH-60A BLACK HAWK helicopter and AH-64 Advanced Attack Helicopter (AAH). During 1977, the Navy selected a derivative of the T700 engine for use in the Light Airborne Multi-Purpose System (LAMPS) MK III (SH-60B) helicopter. The successful STAGG program validated significant engine performance improvements in the critical gas generator section. Technology validated under STAGG has been integrated into Air Force secondary power systems, commercial helicopters, and ongoing Army helicopter development programs. In reviewing the Army's

Program Element: #6.32.01.A  
DoD Mission Area: #233 - Aircraft Propulsion Technology

Title: Aircraft Power Plants and Propulsion  
Budget Activity: #2 - Advanced Technology Development

future propulsion needs it has been determined that the greatest improvement in future aircraft systems can be realized through technology verification in an engine of approximately 800 shaft horsepower (SHP). The technology demonstrated in this program provides the basis for an engineering development program for future applications such as for an advanced scout helicopter. Detailed accomplishments in the 800 SHP Advanced Technology Demonstrator Engine (ATDE) program are covered in the Congressional Descriptive Summary for Project D447, Demonstrator Engines. Also under this program element, several new and/or unique approaches to helicopter transmission design have been or are being validated through experimental hardware testing. Some of the designs and approaches which are now incorporated in production and/or developmental helicopters are: (1) use of ZE41 magnesium as a transmission housing material in civil applications and in the Army's UH-60A BLACK HAWK helicopter, AH-64 Advanced Attack Helicopter (AAH), CH-47D helicopter, and the Navy's SH-60B helicopter; (2) high speed spiral bevel gears in the UH-60A and SH-60B helicopters; and (3) cylindrical roller bearing in the UH-60A and SH-60B helicopters. During FY 1978, the Advanced Transmission Component program resulted in: (1) manufacturing of high contact ratio test gears; (2) advanced design thrust carrying cylindrical roller bearing was fabricated and tested for over 200 hours; (3) completed design of modified tapered roller bearing; (4) completed fabrication of magnetic seals; and (5) defined the heat treatment required for new X-53 gear material.

2. FY 1979 Program: Continue the 800 shaft horsepower Advanced Technology Demonstrator Engine program with the two selected contractors, AVCO Lycoming and Detroit Diesel Allison (DDA). Program goals are to demonstrate significant improvements in engine performance (reduction of specific fuel consumption by 20 percent and increase in specific horsepower of 25 to 35 percent) with improvements in reliability, maintainability, and survivability characteristics compared to current engines in this class, while offering potential for a substantial reduction in production cost. Detailed plans for the 800 SHP ATDE program and other engine-related new starts for each year are described in the Congressional Descriptive Summary for project D447, Demonstrator Engines. Each 800 SHP Advanced Technology Demonstrator Engine contractor will complete all detail design analysis, hardware fabrication, and component rig testing. Full engine testing will be initiated this year.

3. FY 1980 Planned Program: Each 800 horsepower ATDE contractor will complete development testing of the engine and initiate the final demonstration testing.

4. FY 1981 Planned Program: Each 800 horsepower ATDE contractor will complete all demonstration testing and reports. A Fuel Efficient Engine (FEE) program will be initiated to validate achievable levels of performance and mechanical integrity of configurations which will allow fuel consumption improvements of 20 to 25 percent for the aircraft/engine combination compared to engines currently being developed in the 1 to 5 pound per second airflow class. Under the STAGC II concept, two programs will be initiated to validate results from successful exploratory development components efforts in a real engine environment:

Program Element: #6.32.01.A  
DoD Mission Area: #233 - Aircraft Propulsion Technology

Title: Aircraft Power Plants and Propulsion  
Budget Activity: #2 - Advanced Technology Development

(1) thermal control turbine shrouds for enhanced engine performance (up to 5 percent in both specific power and specific fuel consumption) at no increase in engine cost; (2) cooled radial turbine that has the potential of 5 percent performance improvement and cost reduction over cooled axial turbines. A program will be initiated to evaluate erosion resistant compressor coatings in a sand and dust environment. A program to demonstrate the use of a spring-type, advanced, overrunning clutch in a current aircraft drive system will be initiated. This clutch promises reduced weight, cost, and improved reliability over existing clutches. A lightweight drive system program to achieve weight reductions of up to 20 percent, cost reductions of up to 25 percent, and reliability improvements of 20 to 50 percent will be initiated.

5. Program to Completion: This is a continuing program.



FY 1980 RUTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #DM47

Program Element: #6.32.01.A

DOD Mission Area: #233 - Aircraft Propulsion Technology

Title: Demonstrator Engines

Title: Aircraft Power Plants and Propulsion

Budget Activity: #2 - Advanced Technology Development

A. DETAILED BACKGROUND AND DESCRIPTION: The objective of this project is to provide a validated technology base for small (less than 20 lbs/sec airflow) engines. The Army is the largest user and the lead Service for development of small engines. Although the Army will receive the most benefit from this project, the technology is applicable Department of Defense (DOD) wide. Advanced engine configurations are designed, fabricated, and ground and flight tested. Advanced component technology from Government exploratory development and industry-sponsored programs will be applied to advanced gas generators and experimental engines for demonstration and evaluation tests. Applications of advanced materials are evaluated and cost reduction concepts validated. Developmental aircraft must use advanced technology propulsion systems if future aircraft systems are to satisfy projected mission requirements at minimum cost and with minimum utilization of critical fuels and manpower. This project will experimentally validate the applicability and potential of engines utilizing advanced component technology. Successful completion of the 1500 shaft horsepower (SHP) Demonstrator Engine program, which resulted in minimizing of T700 engineering development program cost and risk, validated this approach.

B. RELATED ACTIVITIES: Mutual exchanges of information occur with the United States Air Force, the United States Navy, and National Aeronautics and Space Administration and other US Army Commands interested in turbine engines for ground vehicle and ground power applications. Agencies are advised of program progress by semi-annual meetings, a Tri-Service Propulsion Technology Coordinating Paper, an Informal Tri-Service Coordination Group, and visits to industry. The program is geared to exchange technology advances with other Services and Army agencies. Examples include the use of this technology in a US Army Mobility Equipment Research and Development Command 30 kilowatt generator set and the auxiliary power unit for the United States Air Force A-10 aircraft. Related program elements are 6.22.09.A, Aeronautical Technology; and 6.42.06.A, Utility Tactical Transport Aircraft System (T700 Engine Project).

C. WORKED PERFORMED BY: Detroit Diesel Allison Division, General Motors Corporation, Indianapolis, IN; and AVCO Lycoming Division, Stratford, CT. The program is the responsibility of the Applied Technology Laboratory of the US Army Research and Technology Laboratories, US Army Aviation Research and Development Command, Fort Eustis, VA.

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Two successful efforts that have been completed were the 1500 shaft horsepower (SHP) Demonstrator Engine program and the Small Turbine Advanced Gas Generator (STAGG) program. The 1500 SHP Demonstrator Engine program identified the capabilities and limitations of an engine in that size class and has since transitioned through full engineering development as the T700 engine which is the power plant for the Army's UH-60A BLACK HAWK helicopter and AH-64 Advanced Attack Helicopter (AAH). During 1977, the Navy selected a derivative of the T700 engine for the Light Airborne Multi-Purpose System (LAMPS)

Project: #1447

Program Element: #6.32.01.A

DoD Mission Area: #233 - Aircraft Propulsion Technology

Title: Demonstrator Engines

Title: Aircraft Power Plants and Propulsion

Budget Activity: #2 - Advanced Technology Development

MC III (SH-60B) helicopter. The T700 engine has also been selected for the Bell 214 ST helicopter for export sale to Iran. In reviewing the Army's future propulsion needs it has been determined that the greatest improvement in future aircraft systems can be realized through technology verification in an engine of approximately 800 shaft horsepower (SHP). Progress under the 800 SHP Advanced Technology Demonstrator Engine (ATDE) program included awarding two firm fixed price contracts, effective 1 February 1977. Efforts to date include finalization of detail design, accumulation of 2000 hours of component rig testing, successful completion of 50 hours of preliminary gas generator testing, and ordering of long lead time items for FY 1979 engine fabrication. Fabrication of mock-ups to be used as engineering design tools has been completed. The 800 horsepower ATDE will be the world's most advanced turboshaft engine in the 400 to 1000 horsepower class. A cooperative Army/Navy program resulted in the first successful testing of ceramic bearings in an Army Variable Speed Target Trainer (VSTT) engine and a Navy HARPOON missile engine.

2. FY 1979 Program: Continue the 800 shaft horsepower ATDE program with the two selected contractors, AVCO Lycoming and Detroit Diesel Allison (DDA). Program goals are to demonstrate significant improvements in engine performance (reduction of specific fuel consumption by 20 percent and increase in specific horsepower of 25 to 35 percent) with improvements in reliability, maintainability, and survivability characteristics compared to current engines in this class, while offering potential for a substantial reduction in production cost. Each 800 horsepower ATDE contractor will complete all detail design analysis and hardware fabrication. Hardware modifications will be accomplished as required. Component rig testing will be completed with the option of additional testing available if required to substantiate performance or mechanical integrity. Gas generator testing will continue (with option for additional testing as required) using final design ATDE hardware. Full engine development testing will be initiated in mid-year with the objectives of defining baseline performance and substantiating the mechanical design.

3. FY 1980 Planned Program: Each 800 horsepower ATDE contractor will complete development testing of the engine and initiate the final demonstration testing to include low cycle fatigue, sand and dust ingestion, performance, inlet temperature distortion, and exhaust emissions. Approximately 900 hours of engine testing and 3000 hours of component testing will be accumulated by the end of FY 1980. A maintainability teardown demonstration will be conducted during the fourth quarter of the year. Demonstration testing and preparation of final reports will also be initiated.

Project: #D447  
 Program Element: #6.32.01.A  
 DoD Mission Area: #233 - Aircraft Propulsion Technology

Title: Demonstrator Engines  
 Title: Aircraft Power Plants and Propulsion  
 Budget Activity: #2 - Advanced Technology Development

4. FY 1981 Planned Program: Each 800 horsepower Advanced Technology Demonstrator Engine (ATDE) contractor will complete all demonstration testing and reports. A Fuel Efficient Engine (FEE) program will be initiated to validate achievable levels of performance and mechanical integrity of configurations which will allow fuel consumption improvements of 20 to 25 percent for the aircraft/engine combination as compared to engines currently being developed in the 1 to 5 pound per second airflow class. Under the Small Turbine Advanced Gas Generator (STAGG) II concept, two programs will be initiated to validate results from exploratory development components efforts in a real engine environment: (1) thermal control turbine shrouds for enhanced engine performance (up to 5 percent) at no increase in engine cost; (2) cooled radial turbine that has the potential of 5 percent performance improvement and cost reduction over cooled axial turbines. A program will be initiated to evaluate the US Army Materials and Mechanics Research Center (AMMRC) developed erosion resistant compressor coatings in a sand and dust environment.

5. Program to Completion: This is a continuing program.

6. Major Milestones:

Major Milestones	Current Milestone Dates	Milestone Dates	
		Shown in FY 1979 Submission	
Advanced Technology Demonstrator Engine Milestones			
Complete Preliminary Design of Both 800	FY 1978		FY 1978
Shaft Horsepower Engines			
Initiate Gas Generator Testing	FY 1978		FY 1978
Complete Detail Design, Analysis, and	FY 1979		FY 1979
Hardware Fabrication			
Complete Gas Generator Testing	FY 1979		FY 1979
Initiate Test of Complete Engine	FY 1979		FY 1979
Complete Development Testing and Initiate	FY 1980		FY 1980
Demonstration Testing			
Complete Maintainability Teardown Test and	FY 1981		FY 1980
Demonstration Testing			

The maintainability teardown test will be accomplished in FY 1980. The final demonstration tests will carry-over into early FY 1981.



Project: #D447  
 Program Element: #6.32.01.A  
 DoD Mission Area: #233 - Aircraft Propulsion Technology  
 Title: Demonstrator Engines  
 Title: Aircraft Power Plants and Propulsion  
 Budget Activity: #2 - Advanced Technology Development

7. Resources (\$ in thousands):

	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Cost	Not Applicable Not Applicable
ROUTE							
Funds (current requirements)	2905	7000	8300	5000	Continuing		
Funds (as shown in FY 1979 submission)	2905	7000	9625	-	Continuing		

Due to higher priority work in other projects, previously planned efforts for FY 1980 are being deferred to FY 1981.

FY 1980 RDTF CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.06.A

DoD Mission Area: #235 - Qns and Related Technology

Title: Aircraft Weapons  
Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	<u>TOTAL FOR PROGRAM ELEMENT</u>	<u>2865</u>	<u>0</u>	<u>470</u>	<u>2149</u>		<u>Not Applicable</u>
DM43	Aircraft Weapons Fire Control	2524	0	470	1500	Continuing	Not Applicable
DM44	Aircraft Gun Type Weapons	341	0	0	649	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supports the advanced development and testing of new aircraft weapon subsystems (excluding missiles) to improve the capability of aircraft weapon systems employing gun type weapons, and provides data to support engineering development of helicopter armament. This will be achieved by improving system accuracy, terminal effects, airframe compatibility, and overall system reliability.

C. BASIS FOR FY 1980 RDTF REQUEST: Development, fabrication, and demonstration of a fully operable automatic target cueing system will be initiated. Design and fabrication of an all weather fire control system utilizing millimeter wave radar will be initiated. Design and fabrication of an advanced development model of a medium impulse recoil system using the XM230 Chain Gun modified to fire XM789/799 30mm ammunition as a test vehicle.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTF Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
	1577	100	1375	Continuing	Not Applicable

FY 1978 differences were caused by reprogramming funds into DM43 aircraft weapons fire control to support the most mounted sight development program. FY 1979 difference was caused by Congressional action deleting program element funding. FY 1980 differences reflect changes to fund higher priority programs.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.32.06.A

DoD Mission Area: #235 - Guns and Related Technology

Title: Aircraft Weapons

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to continue advanced development of airborne weapon subsystems for future use in helicopters. Proven concepts from exploratory development of new or improved aircraft weapon subsystems are evaluated and directed towards general aircraft use, and towards specific aircraft application. The primary efforts for this program are to design, fabricate, test, and evaluate breadboard and brassboard models, and prototype hardware of airborne weapons and associated equipment for use in the helicopters.

G. RELATED ACTIVITIES: Project personnel maintain close liaison with other military services and with industry to avoid duplication of effort. The Army participates in the Department of Defense Tri-Service Joint Technical Coordinating Group for Munitions Development. Army personnel working within this program participate in the North Atlantic Treaty Organization Air Armament Working Party and the Air Standardization Coordinating Committee, Working Party 20. These groups and working parties provide a medium for exchange of technical information and determination for joint use and standardization of airborne weaponization items. An Army representative serves on the Air Munitions Requirements and Development committee (AMRAD), an organization within the Office of the Secretary of Defense. One function of this committee is the establishment of joint service requirements and development of air munitions. Related exploratory development is conducted under Program Element 6.22.01.A, Aircraft Weapons Technology, and engineering development under Program Element 6.42.02.A, Aircraft Weapons.

H. WORK PERFORMED BY: Contractors are General Electric Company, Binghamton, NY; Electronic Communication Industries, St. Petersburg, FL; Bell Helicopter Company, Fort Worth, TX; Rockwell International, Columbus, OH; Honeywell Inc., Minneapolis, MN. In-house: US Army Aviation Research and Development Command, St. Louis, MO; US Army Armament Research and Development Command, Dover, NJ; US Army Missile Research and Development Command, Huntsville, AL; US Army Test and Evaluation Command, Aberdeen Proving Ground, MD; US Army Electronics Research and Development Command, Fort Monmouth, NJ.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

I. FY 1978 and Prior Accomplishments: Work performed with the goal of improved target acquisition has covered technology areas including electro-optics, infrared, millimeter wave radar, and improved stabilization. Specific efforts include the development and flight testing of airborne laser rangefinders (both gallium arsenide and neogynium yag) as well as moving target indicator radars. The Cobra helicopter night fire control system evaluated the use of a low light level television on the AH-1G. Results indicated that this was not a sound technical approach. Infrared technology has been evaluated for weapon sighting systems at low light levels and under adverse weather conditions and test bed aircraft were used to measure target engagement ranges and employment techniques. Automatic target tracking from an airborne platform was demonstrated by showing compatibility of a special purpose electronic processing unit to operate from television and Forward Looking Infrared (FLIR) type video formats for tracking of targets with remote view sighting systems. In the area of improved weapon subsystem effectiveness, the feasibility of 30mm and 40mm airburst fuzes and 30mm aluminum cased ammunition was established. The feasibility of helicopter anti-radiation missile and use of semi-active lasers for guidance of point target weapons was demonstrated and current programs are underway to further develop and field this technology. Shallow Cone Shaped Charge (SCSC) technology for High Energy Dual Purpose



Program Element: #6.32.06.A

DoD Mission Area: #235 - Guns and Related Technology

Title: Aircraft Weapons

Budget Activity: #2 - Advanced Technology Development

rounds was developed and is being incorporated into ammunition development programs. The REVEYE missile was tested and evaluated for air launched use against ground targets. With respect to weapon system integration problems, specifications for external stores/suspension equipment for Army aircraft were evaluated and are currently being used for the AH-1S and advanced attack helicopter (AAH) systems. Airborne computers were evaluated on the Multi-Weapon Fire Control Test Bed and specification inputs prepared for the AH-1S and the AAH fire control systems. To assist the AH-1S program, the feasibility of an integrated laser rangefinder with input to the rocket fire control subsystem was demonstrated on the XM-65 sight and this hardware is now being incorporated into the AH-1S. In the area of recoil attenuation, a modified 20mm turret with a flight qualified hydraulic constant recoil mechanism was integrated and flight tested. A breadboard model of a mount for the development of a high impulse recoil attenuation device was completed. Based on the data obtained from medium impulse recoil tests, a detailed mathematical model of the recoil mechanism was programmed into a computer to simulate burst firings. Data from this computer were used to further design a recoil mechanism that will be applicable to current attack helicopters. Data from the computer were also used to compare present recoil mechanism forces with mechanism forces for a new hydraulic constant recoil concept. Hardware has been developed and flight testing to evaluate Closed Loop Fire Control System concepts. Results have indicated that refinements are required to make significant improvements in system performance. To assist in the area of reducing detectability of a helicopter, and hence increasing survivability, fabrication, and flight testing of a mast mounted sight feasibility demonstrator was conducted. A contract has been awarded to Bell Helicopter for the design and fabrication of a non-rotating platform for a feasibility demonstration of the Mast Mounted Sight on the OH-58C helicopter.

2. FY 1979 Program: This Program Element is unfunded for FY 1979.

3. FY 1980 Planned Program: The internal bearing stabilized sighting unit will complete initial flight test. Software for an anti-helicopter fire control systems will be developed. Flight test of the automatic target cueing system will be initiated. Millimeter wave radar long lead time items will be procured. Effort will be initiated to incorporate pertinent data base acquired from related work on gun/turret interface dynamics to design and fabricate an advanced development model of a medium impulse recoil system using the XM230 Chain Gun modified to fire XM89/799 30mm ammunition. Ground firing test will be accomplished utilizing a six degree of freedom simulator to establish pre-flight performance data. A draft development specification for a medium impulse recoil system will be prepared.

4. FY 1981 Planned Program: Hardware/software fabrication will be continued on the automatic target cueing system, millimeter wave radar system, and anti-helicopter fire control system. Limited bench tests will be conducted on components of all systems. Flight tests of the medium impulse recoil advanced development model will be completed and firing data analyzed for refinement of key components including the fast acting servo-valve and microprocessor interfaces. Weight and cost data base will be refined to identify areas for further weight and cost reduction. Effort will be initiated to develop and fabricate an engineering model of the medium impulse recoil system. A draft engineering specification will be prepared. Initiate integration of sensors for precision gun fire control system and verification of ballistic equations for flat trajectory weapons. Incorporate air-to-air defensive fire capability into the multiple weapons fire control system by developing software which considers engagement range, aircraft maneuvers, and hardware constraints.

Program Element: #6.32.06.A

DoD Mission Area: #235 - Qns and Related Technology

Title: Aircraft Weapons

Budget Activity: #2 - Advanced Technology Development

5. Program to Completion: This is a continuing program.

FY 1980 RDTF CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6. 32.07.A

DoD Mission Area: #215 - Command and Control

Title: Aircraft Avionics Equipment

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>1660</b>	<b>804</b>	<b>1945</b>	<b>6374</b>		<b>Not Applicable</b>
DB96	Aircraft Navigation & Control Equipment	387	0	300	1312	Continuing	Not Applicable
DB97	Avionics Equipment	1273	804	745	1612	Continuing	Not Applicable
D312	Nap-of-the-Earth Essential Equipment Development	0	0	900	3450	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** This program element provides for technology demonstration and advanced development leading to engineering development of avionics and related ground equipment. Emphasis is on hardware which will enable day/night, adverse weather aviation operations in a mid-intensity warfare environment.

**C. BASIS FOR FY 1980 RDTF REQUEST:** Operate Joint Tactical Microwave Landing System lead service program office. Flight test feasibility models of airborne data transfer system. Configure test bed helicopter as a flexible flight research tool. Start advanced development of target hand-off system for use on new scout and attack helicopters.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTF Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
	1660	1304	2375	Continuing	Not Applicable

FY 1979 change is due to Armed Service Committees' deletion of funds for the Joint Tactical Microwave Landing System (JTMLS). FY 1980 change is the net result of providing Project DB96 funds for JTMLS program office, funding new Project D312, and reducing level of effort in Project DB97.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: 16.32.07.A

DoD Mission Area: 1215 - Command and Control

Title: Aircraft Avionics Equipment

Budget Activity: 12 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION:

1. Project DB96 (Aircraft Navigation and Control Equipment). The Federal Aviation Administration (FAA) manages and funds the National Microwave Landing System (NMLS) development. DOD and the National Aeronautics and Space Administration (NASA) have conducted and funded supporting activities such as testing in military aircraft. The Office of the Secretary of Defense (OSD) designated the Army as lead service for the Joint Tactical Microwave Landing System (JTMLS), a tactical derivative of the NMLS. \$6.5 million transferred from the PAA to DOD will be used for JTMLS advanced development. The Armed Services Committees deleted DOD FY 1979 funding for MLS, without prejudice. The Army, along with the other Services and The Office of the Under Secretary of Defense, Research & Engineering (OUSDRE) is formulating the advanced development JTMLS program. A study of MLS cost performance trade-offs is being prepared for the Armed Services Committees.
2. Project DB97 (Avionics Equipment). Army aviation needs are addressed in the areas of nap-of-the-earth (NOE) communications, electronic counter-countermeasures (ECM) for aircraft radios, VHF-FM communications, all-digital aircraft system, airborne data transfer system, and improved antennas. Technical barriers need to be overcome in order to develop equipment for tactical low level operations which will meet requirements of cost, reliability, and compatibility with the helicopter environment. Work includes development of cockpit instrumentation tailored to flight characteristics and mission profiles of Army helicopters, improvement of the man-machine interface, and providing new sensors for detection and avoidance of obstacles ranging from wires to terrain masses.
3. Project D312 (Nap-of-the-Earth Essential Equipment Development). This new project was established to fund development of subsystems to significantly enhance helicopter nap-of-the-earth (NOE) operations. Initial emphasis is on improved target hand-off capability. Subsystems developed under this project are expected to have a direct positive impact on combat helicopter mission efficiency.
- G. RELATED ACTIVITIES: In order to avoid unnecessary duplication of effort, related programs of the Air Force, Navy, Federal Aviation Agency, and other organizations are monitored by the Army through committees and working groups. Cost reduction is pursued through joint developments and hardware standardization. This program element is related to Program Elements 6.22.02.A, Aircraft Avionics Technology; and 6.42.01.A, Aircraft Avionics.
- H. WORK PERFORMED BY: Project Manager, Navigation and Control Systems (Project DB96) and Avionics Research and Development Activity (Projects DB97 and D312), Fort Monmouth, NJ. Contractors include American Electronic Laboratory, Lansdale, PA, and Advanced Technology Center, Dallas, TX.
- I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Program Element: #6.32.07.A

Sub Mission Area: #215 - Command and Control

Title: Aircraft Avionics Equipment

Budget Activity: #2 - Advanced Technology Development

1. FY 1978 and Prior Accomplishments: Flight tested system for tactical hover, using already developed sensors indicated that tactical hover may be accomplished with Lightweight Doppler Navigation System (LDNS) and that a dedicated position sensor is not required. Conducted nap-of-the-earth (NOE) communication test/evaluation program for system that operates effectively during NOE flight in an electronic counter-countermeasure (ECCM) environment. Fabricated and integrated programmable symbology generator and multifunction display into the Digital Modular Avionics Program (DIMP). Analyzed acoustical and electrical noise data and developed specifications for audio applique unit (utilizing auto correlation noise cancelling techniques) to reduce headset noise. Developed improved microphone/headset. Developed device to filter out helicopter transmission noise. Evaluated commercial model of broad band automatic direction finding device. Investigated use of liquid crystal displays for helicopter instrumentation. Evaluated conventional flight director systems. Accomplished computer modeling of aircraft vulnerability, survivability, performance, and avionics reliability. Completed development of voice gating circuitry. Evaluated cockpit lighting techniques. Initiated investigation of state-of-the-art low airspeed sensing and display systems. Demonstrated single frequency transmission system. Developed and installed integrated target location and navigation system for Optix IV OH-6A helicopter which provides evaluation of automatic target location, offset navigation update and night hover capability. Conducted steady state hover tests of night navigation and pilotage system. Awarded contract for feasibility models of airborne data transfer system. Completed concept formulation package for nap-of-the-earth communications system. Participated in National Microwave Landing System (NMLS) program, including tri-service testing of NMLS receivers. Award contract for AN/ASN-132 integrated inertial navigation system which will use standard inertial and TACAN hardware developed by the Air Force.
2. FY 1979 Program: Flight test and evaluate night navigation and pilot system. Review design of airborne data transfer system and begin fabrication of feasibility models. Award contract for system for detection of wires and wire-like obstacles. Prepare cost/performance trade-off study on landing systems for presentation to Armed Services Committees. Award advanced development contract for Joint Tactical Microwave Landing System (JTMLS) using funds transferred from Federal Aviation Administration (FAA).
3. FY 1980 Planned Program: Manage JTMLS advanced development contractual effort, and continue to coordinate with FAA, NATO, and other DOD elements on specifications and standards relative to the JTMLS and NMLS programs. Configure System Test-bed for Avionics Research (STAR) as a flexible flight research tool, using state-of-the-art digital data bus interconnection technology. Flight test airborne data transfer system feasibility models. Investigate improvement of aircraft speech communications in a nap-of-the-earth/electronic warfare environment. Award advanced development contract for target hand-off system for use on new scout and attack helicopters.
4. FY 1981 Planned Program: Conduct tri-service test program of JTMLS advanced development prototypes. Upgrade STAR sensors and controls and flight test in a nap-of-the-earth environment. Continue development of target hand-off system.
5. Program to Completion: This is a continuing program.

# FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #b, 32, 09, A  
 DoD Mission Area: #244 - Mobility and Logistics Technology Demonstration  
 Title: Air Mobility Support  
 Budget Activity: #2 - Advanced Technology Development

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	608	286	650	1990	Continuing	Not Applicable
D831	Manufacturing Technology	0	0	0	0	Continuing	Not Applicable
D832	Ground Support Equipment	62	0	0	0	Continuing	Not Applicable
D833	Cargo Handling Equipment	6	0	0	0	Continuing	Not Applicable
D845	Aviation Life Support Equipment	0	0	150	450	Continuing	Not Applicable
D866	Diagnostics and Inspections	290	0	0	740	Continuing	Not Applicable
D103	Helicopter Anti/icing	250	286	500	800	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supports the advanced development and testing of air-mobility prototype support equipment and concepts by advanced systems demonstrations. The concepts being developed are structured to enhance the efficiency, safety, and survivability of air crewmembers operating in a hostile tactical environment.

C. BASIS FOR FY 1980 RDTE REQUEST: Helicopter Antideicing: Completes flight test evaluation of ice protected critical components, initiates advanced development work on ice phobic coatings and fabricates experimental hardware necessary to initiate advanced development of vibratory main rotor blade ice protection techniques. Aviation Life Support: Develops individual items of equipment to enhance the overall crew survivability both while in the aircraft and in a hostile environment if forced to leave the aircraft. The FY 1980 effort will concentrate on the design and fabrication of an advanced development prototype of an aircrew inflatable body and head restraint system.

## D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Costs
	1278	672	1928	Continuing	Not Applicable



Program Element: #6.32.09.A  
DoD Mission Area: #244 - Mobility and Logistics Technology  
Demonstration

Title: Air Mobility Support  
Budget Activity: #2 - Advanced Technology Development

Differences from the FY 1979 Congressional Descriptive Summary reflect the movement of 0266 Airdrop Prototypes and Techniques from Program Element 6.32.09.A Airmobility Support to 6.32.18.A Airdrop Equipment and Techniques. In order to provide increased emphasis and intensive management. Additional changes resulted from realignments of priorities for helicopter anti/deciling, diagnostics and inspections, and aviation life support (previously titled subsystems and components).

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.32.09.A  
DoD Mission Area: #244 - Mobility and Logistics Technology Demonstration  
Title: Air Mobility Support  
Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The objective of this program element is to continue advanced development of conceptual prototypes that allow new items of mission support equipment to enter engineering development. Efforts underway in this program element will lead to development of hardware needed to support current and future aircraft systems and to enhance the safety and survivability to the aircrew/aircraft. The projects under this Program Element (PE) have transitioned from 6.2 exploratory developments at the Aviation Research and Development (Command, Research and Technology Laboratory. The following projects comprise the program element. Manufacturing Technology: While planned for initiation in FY 1978, this project has not been funded. Ground Support Equipment (GSE): Evaluates off-the-shelf equipment on conceptual prototype and concepts to improve and enhance ground support to current and future aircraft systems. Cargo Handling Equipment: Development of new concepts and techniques critically needed for movement of cargo by external sling operations. Equipment developed will enhance the mobility of the Army field units and will enhance the deployment of priority equipment in the mid-intensity environment. Aviation Life Support Equipment (ALSE): Equipment will be developed to provide the aviator survivability in the aircraft and on the ground and to minimize crew injuries by reducing the safety hazards associated in current and future aircraft systems. Diagnostics and Inspection: Automated equipment for condition monitoring and diagnosis of aircraft malfunctions will be developed which will reduce trouble-shooting time, eliminate unnecessary removals of aircraft components, and reduce the life cycle costs. Use of airborne recorders will further improve the identification of faulty aircraft components. This project is unfunded in FY 1979 and FY 1980. Helicopter Anti/Icing: Analysis of helicopter adverse weather capability led to advanced development of electro-thermal anti/icing systems for rotor blades and other critical components. Other concepts such as ice phobic coatings and vibratory/micro-wave techniques will be evaluated.

G. RELATED ACTIVITIES: Aeronautical Technology Program Element 6.22.09.A, Airdrop Technology Program Element 6.22.10.A; Air Mobility Support Equipment; Helicopter Anti/Icing efforts are coordinated with NASA, FAA, USAF, and USN. Project personnel maintained close liaison with other military services and industry to avoid duplication of effort as well as participation in Army-wide development Joint Working Groups. Project personnel maintained coordination with NATO activities in helicopter icing by participation in AC/225 (Panel X) subgroup on Helicopter Icing. Related exploratory development is conducted under PE 6.22.10.A, and engineering development under PE 6.42.04.A (Air Mobility Support Equipment).

H. WORK PERFORMED BY: Contractors are SKF Industries, King of Prussia, PA; Barnes & Reinecke, Chicago, IL. In-house: US Army Aviation Research and Development Command, St Louis, MO; US Army Test and Evaluation Command, Aberdeen Proving Grounds, MD; US Army Training and Doctrine Command (TRADOC), Ft Monroe, VA. US Army Troop Support & Aviation Materiel Readiness Command, St Louis, MO.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Ground Support Equipment: Operational tests were conducted to determine suitable equipment and techniques for rapid loading in forward areas. Cargo Handling: Feasibility of a helicopter transported Container Lift Adapter (CLA) for acquiring, transporting, and delivering standard 8 x 20 foot MILVAN container, without the aid of ground

Program Element: #6.32.09.A  
DoD Mission Area: #244 - Mobility and Logistics Technology  
Title: Air Mobility Support  
Budget Activity: #2 - Advanced Technology Development  
Demonstration

personnel or preflighting has been demonstrated. The gondola system for external transport by helicopter of noncontained cargo was fabricated and flight tested. Diagnostics and Inspections: Testing of a complete diagnostic system on the UH-1H helicopter using implanted faulty components has been completed. Aviation Life Support Equipment (formerly Subsystems and Components): Defined requirements for the Aircrew Integrated Helmet. Helicopter Anti-Icing: Project started in 1977, with analysis of ice protection requirements for Army helicopter. Initiation of design, fabrication, and installation of ice protected components for UH-1H test helicopter. Initial flight tests in both returned and simulated icing conditions were completed.

2. FY 1979 Program: Project DB31, Manufacturing Technology; DB32, Ground Support Equipment; DB33, Cargo Handling Equipment; DB45, Aviation Life Support Equipment; and DB66, Diagnostic; are unfunded for FY 1979. Helicopter Anti-Icing: The ice protected test aircraft (UH-1H) will be used as a flying test-bed to determine flight characteristics and evaluate ice protection equipment for other critical subsystems and accomplish flight test certification of the UH-1H partial ice protection kit (Kit A). Kit A includes an anti-ice windshield, an ice detector and some other electrical and structural modifications, all of which were derived from 1977 and 1978 icing tests of the fully-protected UH-1H testbed aircraft. Kit A will be procured and fielded in USAREUR in response to an urgent requirement for partial ice protection. Continuation and verification of established design criteria for icing equipment and correlation of natural icing tests.

3. FY 1980 Planned Program: Projects DB31, Manufacturing Technology; DB32, Ground Support Equipment; DB33, Cargo Handling Equipment and DB66 Diagnostics and Inspection are unfunded in FY 1980. Aviation Life Support Equipment: Initiate advanced development of the Inflatable Body and Head Restraint System which successfully completed exploratory development (6.2) under US Navy lead. Award of incrementally funded contract for the design and fabrication of advanced development prototype. Helicopter Anti-Icing: Advanced development of vibratory rotor-blade ice protection concepts will be initiated with test hardware design and fabrication. Advanced development of ice phobic rotor blade coating materials (such as IOW 2460 Sili-cone Compound) will be initiated using results from the 6.2 effort. Ice phobic coatings offer the potential to permit operations in icing conditions with minimum aircraft weight and complexity penalties.

4. FY 1981 Planned Program: Manufacturing Technology, Ground Support Equipment, Cargo Handling projects are unfunded in FY 1981. Aviation Life Support Equipment: Continuation of development of the Inflatable Body and Head Restraint system, initiated in FY 1980; Completion of in-house laboratory tests; Initiate developmental and operational tests. Initiate development of the Improved Lighting Systems for Army Aircraft (ILSAA), to identify candidate systems for current aircraft fleet. Diagnostic and Inspection: Exploratory development of a device called "LOG MOD" will transition to advanced development in FY 1981. The LOG-MOD will analyze fault indicators, and through programmed logic prescribe the appropriate corrective measures. A development plan will be prepared. The advanced application of vibration monitoring will be investigated. Helicopter Anti-Icing: Advanced development of rotor-blade ice protection concepts will be continued with the initiation of microwave techniques. Test hardware from earlier program will be refined to permit engineering development, if warranted and required.

5. Program to Completion: This is a continuing program.



# FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.11.A  
DoD Mission Area: #232 - Aeronautical Vehicle Technology  
Title: Rotary Wing Controls, Rotors, and Structures  
Budget Activity: #2 - Advanced Technology Development

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total	
								Estimated Costs	Not Applicable
D157	Advanced Rotors/Flight Controls		1627	2652	0	0			
D841	Advanced Structures		350	700	2500	6760	Continuing		Not Applicable
D313	Research Aircraft Systems		0	0	350	500	Continuing		Not Applicable
D314	Advanced Rotor Systems		0	0	931	3100	Continuing		Not Applicable
D315	Advanced Flight Controls		0	0	2119	3700	Continuing		Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army's advanced development program for rotary wing flight controls, rotors, and structures provides for the development and demonstration of full scale aircraft components and subsystems for advanced rotor concepts and demonstration of improvements in rotary wing aircraft flight controls. An advanced aircraft structures technology base will be developed as a major thrust to evaluate potential for increased combat survivability, improved reliability and maintainability, lower weight, and longer life with substantial life cycle cost saving over conventional method structures.

C. BASIS FOR FY 1980 RDTE REQUEST: To extend the evaluation flight envelope for the *Bearingsless Main Rotor* on the BO-105 helicopter; to continue acquisition of baseline data on the Rotor Systems Research Aircraft (RSRA) with the S-61 rotor; to perform preliminary design studies on an advanced rotor concept for demonstration using the RSRA; to support research aircraft flight operations; to define redundancy management concepts for advanced Fly-By-Wire (FBW) flight control systems; to initiate component bench tests and a flight demonstration program for FBW hardware; and to initiate the Advanced Composite Aircraft Program (ACAP) which will introduce advanced composite materials into the primary helicopter fuselage.

Program Element: #6.32.11.A

DoD Mission Area: #232 - Aeronautical Vehicle Technology

Title: Rotary Wing Controls, Rotors, and Structures  
Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>	<u>Additional to Completion</u>	<u>Total Estimated Cost</u>	<u>Not Applicable</u>
RDTE						
Funds (as shown in FY 1979 submission)	1928	3352	10066	Continuing		

Changes between the 1980 and 1979 submissions reflects an overall reduction in available funds to pursue research objectives, associated delays in starting the Advanced Composite Airframe Program (ACAP) and a reduction in scope of advanced rotors research in FY 1980. This program element has been restructured from the FY 1979 submission by the establishment of Projects D313, D314, and D315. These projects are restructured from D157 to form essential, stand alone, single thrust initiatives with high payoff potentials.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.32.11.A

BoB Mission Area: #232 - Aeronautical Vehicle Technology

Title: Rotary Wing Controls, Rotors, and Structures  
Budget Activity: #2 - Advanced Technology Development

**F. DETAILED BACKGROUND AND DESCRIPTION:** This advanced development program provides for the development, verification, and demonstration of technology in areas currently restricting Army airborne systems. This continuing program is formulated on the basis that advances in state-of-the-art technology will only be made if technology is validated and technical confidence is gained through component or system demonstration in actual or simulated flight conditions. The program includes efforts in advanced rotors and flight control systems, and in the application of advanced structures. Foreign state-of-the-art trends, potential threats to the present and future materiel systems throughout the Research and Development cycle have been considered.

**G. RELATED ACTIVITIES:** The technology being developed and demonstrated in this program is related to Navy, Air Force, and National Aeronautics and Space Administration (NASA) programs. Coordination with these agencies and others is accomplished on a continuing basis through joint program reviews; exchange of data sheets and reports; The Technical Cooperation Program; NASA Research and Technology Committees; North Atlantic Treaty Organization (NATO) Standardization Agreements (STANAGs); and the NATO Advisory Group on Aerospace Research and Development. This program is included in the tri-Services Aeronautical Vehicle and Structures Technology Coordinating Papers. Efforts under this program are related to activities under Program Elements 6.22.09.A, Aeronautical Technology; and 6.32.12.A, Tilt Rotor Research Aircraft; as well as major Army aircraft systems under development. The Tilt Rotor Research Aircraft program and the rotor research program utilizing the Rotor Systems Research Aircraft are jointly funded by NASA and the Army and the high speed evaluation of the Advancing Blade Concept Compound Configuration is jointly funded by NASA, the Navy, and the Army. The aeroelastically conformable rotor and hover agility rotor programs are co-funded by both projects within this program while the bearingless main rotor program is co-funded with Program Element 6.22.09.A, Aeronautical Technology. Numerous tasks in this program had their origin within efforts performed in Program Element 6.22.09.A.

**H. WORK PERFORMED BY:** This work is performed by the Research and Technology Laboratories of the US Army Aviation Research and Development Command located at Moffett Field, CA; Fort Eustis, VA; and Langley, VA. Work in related activities is also performed by the National Aeronautics and Space Administration (NASA) Ames and Langley Research Centers, located at Moffett Field, CA, and Langley, VA. The top five contractors are: Hughes Helicopters, Culver City, CA; Sikorsky Aircraft, Stratford, CT; Boeing Vertol Company, Philadelphia, PA; Kaman Aerospace Corporation, Bloomfield, CT; and Bell Helicopter Textron, Fort Worth, TX. Much of the contract work for FY 1979 is competitive and the contractors are to be determined. The total anticipated contract dollar value for FY 1980 is \$4,963,000.

**I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

**1. FY 1978 and Prior Accomplishments:** A Bearingless Main Rotor (BMR) flight evaluation program progressed through the design and analysis phases, completion of wind tunnel tests of the BMR/BO-105 helicopter and completion of ground testing of components and rotor. A High Energy Rotor (HER) was flight tested to demonstrate the potential to eliminate the "deadman's" curve for autorotation. A fan-in-fin anti-torque and directional control system was evaluated in flight test. A hydrofluidic stability augmentation system for light helicopters was developed and tested on the OH-58 helicopter. Initial development of a UH-1H helicopter in-flight simulator was completed as were studies for development of a similar system for the XV-15 Tilt Rotor Research



Program Element: #6.32.11.A

BoD Mission Area: #232 - Aeronautical Vehicle Technology

Title: Rotary Wing Controls, Rotors, and Structures  
Budget Activity: #2 - Advanced Technology Development

Aircraft. Preliminary program planning for development of an advanced Fly-By-Wire control system was initiated. The XH-59A Advancing Blade Concept (ABC) aircraft was tested as a pure helicopter up to speeds of 160 knots indicated airspeed during a 67-hour flight test program. Under a joint Army/Navy/National Aeronautics and Space Administration (NASA) program, the XH-59A was modified to add two J-60 turbojet engines for high speed flight testing. The Composite Multi-Tubular Spar main rotor blade for the AH-1G has been successfully flight demonstrated. From this program the Improved Main Rotor Blade for the AH-1S evolved. A composite tail section has been designed for the OH-58 and will be flight tested and put into limited service soon in order to accumulate flight service experience with a composite structure. A Structural Integrity Recording System (SIRS) for monitoring fatigue damage accumulation on dynamic components has been flight demonstrated. Several major items for nondestructive tests have been acquired. Innovative composite ballistic tolerant structural concepts have been successfully demonstrated in multiple explosive projectile impact tests. High energy absorption landing gear have been designed and tested.

2. FY 1979 Program: A 25 hour flight test program on the Bearingless Main Rotor (BMR) on the BO-105 helicopter will be conducted to determine loads, rotor stability and handling qualities. Flight test data analysis will be completed. The capability to predict structural and aeroelastic response, loads, rotor stability, handling qualities and performance characteristics of the BMR will be evaluated. Funding will be provided for operational support of the Rotor Systems Research Aircraft (RSRA), including contract support, acquisition of spares, acquisition of automatic test equipment for routine maintenance, and in-house personnel support. Flight programs in Aerodynamics Technology, Flight Response Technology and Vibration Technology using the RSRA aircraft with the delivered S-61 rotors will be initiated. Baseline noise data on the RSRA S-61 rotor will be obtained using the In-Flight Far-Field Impulsive Noise Measurement concept. A set of helicopter configurations will be derived to systematically investigate individual basic handling qualities characteristics such as speed stability or cross-coupling limits using the UH-1H helicopter in-flight simulator. The evaluation of these configurations in daylight terrain flight tasks will be initiated. Flight test of the XH-59A Advancing Blade Concept (ABC) aircraft in the high speed configuration will be completed.

3. FY 1980 Planned Program: D313: Contributes Army's share supporting flight operations of research aircraft - Rotor Systems Research Aircraft (RSRA) and the UH-1H in-flight simulator. D314: Additional testing to expand the demonstration envelope of the Bearingless Main Rotor (BMR) program will be initiated. Advanced rotor technology programs will continue using the RSRA's unique capabilities. Candidate rotor programs are the Vibration Technology program, the Flight Response Technology program (utilizing on both conventional and compound helicopter configurations), aeroelastically conformable, and hover agility. D315: Evaluation of handling qualities configurations on the UH-1H helicopter in-flight simulator for daylight tasks will be completed. Incorporation of visual aids in the simulation for extending the evaluation to simulated night and poor visibility conditions will be started. D315: A program to design, fabricate, bench test and flight test a Fly-By-Wire (FBW) control system will be initiated. A competitive selection of test aircraft and Contractor/Developer will be made. In support of this effort, development of redundancy management concepts will be completed. In support of digital FBW systems, test of digital mechanisms for wire and optical beam systems will be initiated, as will design, fabrication, and bench test of a digital/optical servovalve.

Program Element: #6, 32.11.A  
DoD Mission Area: #232 - Aeronautical Vehicle Technology

Title: Rotary Wing Controls, Rotors, and Structures

Budget Activity: #2 - Advanced Technology Development

DB41: The Advanced Composite Airframe Program (ACAP) to introduce advanced composite materials into the primary helicopter fuselage structure will be initiated. The purpose of the program is to reduce structural weight, increase safety and survivability, reduce helicopter fleet life cycle costs, and increase combat readiness. These improvements will be demonstrated by designing, building, testing and flying a helicopter with an all-composite fuselage. The first years effort on the Advanced Composite Airframe Program (ACAP) will complete the first phase preliminary design, trade-off studies and concept selection. This will involve multiple contractors. The second phase will begin in the third quarter. This will involve detailed design and critical component testing by two contractors.

4. FY 1981 Planned Program: Bearingless Main Rotor (BMR) envelope expansion will be completed. As a follow-on to the High Energy Rotor program, a program to design, fabricate and test a Hover Agility Rotor (HAR) will be initiated, taking advantage of new composite materials. Rotor design will be optimized for inertia or alternate energy sources to provide improved safety, controllability and improved helicopter stability. Rotor Systems Research Aircraft (RSRA) operations support will continue. A vibration Technology Program and a Flight Response Technology Program on the RSRA will be completed. A program to test an Advanced Attack Helicopter (AAH) or UH-60A BLACK HAWK rotor on the RSRA will be initiated. Design and fabrication of an advanced technology rotor for RSRA testing will continue. A research rotor configuration with advanced rotor blade geometry for improved performance and acoustic characteristics will be selected for tests. Selective UH-1H helicopter in-flight simulator experiments will be accomplished and joint Army/National Aerospace and Space Administration (NASA) advanced controls research will continue. Hardware fabrication for the Fly-By-Wire (FBW) system will be initiated and a competition for development of an all digital system will be completed. Tests of digital/optical servo valve will be completed. A program to establish digital multiplexing requirements will be initiated. The second year of the ACAP program will continue the critical element testing and detailed design. Specific tooling and fabrication work on the major structural subcomponents will begin.

5. Program to Completion: This is a continuing program.

**FY 1980 RUTE CONGRESSIONAL DESCRIPTIVE SUMMARY**

Program Element: #6.32.16.A Title: Synthetic Flight Simulators  
 DoD Mission Area: #244 - Mobility & Logistics Technology Budget Activity: #2 - Advanced Technology Development  
Demonstration

**A. RESOURCES (PROJECT LISTING): (\$ in thousands)**

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
<b>TOTAL FOR PROGRAM ELEMENT</b>							
DB34	Rotorcraft Systems Integration Simulator (RSIS)	734	400	1200	5550	Continuing	Not Applicable
DB35	Aviator Training Research Simulator (ATRS)	0	0	0	2500	Continuing	Not Applicable
DB39	Flight Simulator Components (FSC)	734	0	0	1000	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** This program provides for the development of a versatile, high fidelity, ground based, helicopter simulators to support Army aviation system and training developments. Simulation uses include support of conceptual design trade-offs, prototype development, flight tests and product improvement evaluations (DB34); examination of training techniques for initial entry training, transitional/refresh training and combat readiness flying (DB35); and development of advanced flight simulation components and systems for incorporation into future flight training systems (DB39).

**C. BASIS FOR FY 1980 RUTE REQUEST:** Award contract for fabrication of Rotorcraft Systems Integration Simulator (RSIS) cab and fixed base station. Initiate preliminary design studies for RSIS advanced visual system.

**D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)**

RUTE	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
Funds (as shown in FY 1979 submission)	1004	400	4790	Continuing	Not Applicable



Program Element: #6.32.16.A

DoD Mission Area: #244 - Mobility & Logistics Technology  
Demonstration

Title: Synthetic Flight Simulators  
Budget Activity: #2 - Advanced Technology Development

Reduction in FY 1978 is due to slight decrease in level of effort on Flight Simulator Components (DB39). Reduction in FY 1980 estimate is due to deferral of work on Aviator Training Research Simulator (DB35) and Flight Simulator Components (DB39) in order to fund higher priority programs.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.32.16.A  
DoD Mission Area: #244 - Mobility & Logistics Technology

Title: Synthetic Flight Simulators  
Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: Rotorcraft Systems Integration Simulator (RSIS): The Army Scientific Advisory Panel (ASAP) Ad Hoc Working Group on Research Facility Requirements for Map-of-the-Earth (NOE) Day/Night Visual Flight Studies recommended that the Army, who is the lead service for helicopter R&D, place increased emphasis on research and development in helicopter flying qualities using ground based simulation. The Rotorcraft Systems Integration Simulator (RSIS) will be a modification of the National Aeronautics and Space Administration (NASA) Vertical Motion Simulator by the US Army Research and Technology Laboratory, exploiting the Joint Army-NASA agreement to minimize costs and to obtain technical expertise, to develop this aeronautical engineering research facility. The Army Scientific Advisory Panel (ASAP) recommended a modest increase in flexibility of an existing training simulator for research on training. The Aviator Training Research Simulator (ATRS) will be developed by enhancing an existing UH-1 Flight Simulator (2824) at Fort Rucker, Alabama with a visual display and a training experiment station. This will require software integration of the motion base, visual system, and helicopter flight characteristics. Training research will be guided by a Joint Army/Navy/Marine Corps coordination committee. Army training research will address initial entry rotary wing training, transitional refresher training and combat readiness training. The Flight Simulator Components (PSC) program provides for development of advanced flight simulation components which can be incorporated into training devices for future aviation systems or used to improve the training ability of current Army simulators. Efforts include improving representation of real world visual scenes by increasing field of view and scene content, increasing size of gaming areas, inclusion of enemy interaction (tanks, tracer fire) and improvements in instructor/operating stations.

G. RELATED ACTIVITIES: Program Element 6.42.17.A, Synthetic Flight Training Systems; and 6.22.09, Aeronautical Technology.

H. WORK PERFORMED BY: The Project Manager, Training Devices, Orlando, FL; Naval Equipment Training Center, Orlando, FL; US Army Research and Technology Laboratory, Ames Research Center, Moffett Field, CA; American Airlines Simulator Engineering, American Airlines Plaza, Fort Worth, TX.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Rotorcraft Systems Integration Simulator: Completed preliminary design studies for modifying NASA Vertical Motion System. Procured and began installation of CDC 7600 general purpose digital computer which will satisfy computational requirements of RSIS. Flight Simulator Components: Demonstrated monochrome scene with wide angle laser scan system in September 1978, and prepared for demonstration of monochrome scene with 360° annular visual system in February 1978.
2. FY 1979 Program: Rotorcraft Systems Integration Simulator: Prepare specifications for and award contract for modifying NASA vertical motion system. Complete preliminary design studies for fabrication of rotorcraft cab and construction of fixed-base station.
3. FY 1980 Planned Program: Rotorcraft Systems Integration Simulator: Award contract for fabrication of rotorcraft cab and fixed base station. Initiate preliminary design studies for advanced visual system.

Program Element: #6.32.16.A  
DoD Mission Area: #244 - Mobility & Logistics Technology

Title: Synthetic Flight Simulators  
Budget Activity: #2 - Advanced Technology Development

4. FY 1981 Planned Program: Rotorcraft Systems Integration Simulator: Complete fabrication of rotorcraft cab and fixed base station. Award contract for visual image generator. Aviator Training Research Simulator: Procure computer and integrate with existing cockpit and motion platform. Flight Simulator Components. Accomplish design of computer image generation interface to wide field-of-view laser visual system.

5. Program to Completion: This is a continuing program.



FY 1980 RTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.18.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Airdrop Equipment and Techniques  
Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
D266	Airdrop Equipment & Techniques	701	386	1250	1300	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supports advanced development of airdrop equipment and techniques and responds to documented operational needs (Letters of Agreements and directed actions) for new and improved airdrop operational capabilities. Efforts focused on new airdrop equipment and techniques transition from Program Element 6.22.10.A, Airdrop Technology, to this Program Element for demonstration of technical, operational, and economic feasibility prior to final development and fielding of airdrop equipment. Thus this program element provides a vital and critical link between research and engineering of airdrop equipment and techniques. Airdrop Projects provide systems which are designed to reduce airdrop aircraft vulnerability to enemy air defense, improve operational capability of airborne assault, clandestine, and special operations and provide for airdrop resupply of both conventional and airborne forces for all Services. All projects are included in the US Army Training and Doctrine Command (TRADOC) priority listing as essential to combat support.

C. BASIS FOR FY 1980 RTE REQUEST: Continue advanced development work of: Ultra-High Level Container System, Airdrop Controlled Exit System, Universal Bundle Airdrop System, and Ground Assembly Aids. Complete and transition to engineering development the Staged Parachute System for Personnel with Accompanying Bundles.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Costs
RDTF	701	372	400	Continuing	Not Applicable
Funds (as shown in FY 1979 submission 6.32.09.A/D266)					

Program Element: #6.32.18.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Airdrop Equipment and Techniques  
Budget Activity: #2 - Advanced Technology Development

This program was significantly underfunded in FY 1979. The increase in FY 1980 reflects an attempt to bring this program in line with the 6.2 and 6.4 airdrop programs.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.32.18.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Airdrop Equipment and Techniques

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The work under this program element was formerly under program element 6.32.09.A. Major areas of effort are: The development of a high level cargo airdrop prototype system capable of delivery from an altitude of 7600 meters with an accuracy of 200 meters; the design of a functional prototype system to solve the problem of excessive drop zone dispersion for heavy drop platform loads; the demonstration of a two-stage personnel airdrop system for the airdrop of special forces teams of parachutists with accompanying bundles from aircraft flying at 250 knots and 150 meters altitude; development of an airdrop system for the delivery of bundles of equipment and parachutists in a single pass over the drop zone; and the conduct of advanced development of candidate ground assembly aids to permit rapid location and identification of airdropped equipment and rapid assembly of airdropped personnel under conditions of low visibility and night.

G. RELATED ACTIVITIES: Program Element 6.22.10.A, Airdrop Technology; Program Element 6.42.18.A, Airdrop Equipment Development; Joint Air Movements Board; Joint Technical Coordinating Group/Airdrop; Mutual Weapons Data Exchange Agreements with France and Germany; North Atlantic Treaty Organization Air Transport Working Party and Air Standardization Coordinating Committee, Working Party 44, Standardization Agreements.

H. WORK PERFORMED BY: Payne Inc., Annapolis, MD; AAI Corporation, Baltimore, MD; Pioneer Parachute Company, Manchester, CT; Irvin Industries Ltd, Canada; Georgia Tech Research Institute, Atlanta, GA; Arthur D. Little, Jr., Cambridge, MA; Brooks & Perkins, Livonia, MI; Metric Systems Inc., Ft Walton Beach, FL; US Army Yuma Proving Ground, Yuma, AZ; and US Army Natick Research and Development Command, Natick, MA.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Transitioned to engineering development an airdrop system for resupply from altitudes of 3000 meters; completed concept study for Airdrop Controlled Exit (ACE) system and awarded contract for the fabrication and laboratory tests of early prototype hardware. Completed conceptual design of half-wedge component for the two-staged personnel airdrop system and designed and fabricated a full wedge prototype for test with the C-130 aircraft to provide a near term capability for airdrop of accompanying bundles with parachutists. Awarded contract for the design and static testing of the Ultra-High Level Container Airdrop System (UHLCADS).

2. FY 1979 Program: Complete the design of the recovery system for the Ultra High Level Container Airdrop System and procure flight test quantities of containers. Complete advanced development of the Two-Stage Personnel Parachute System and transition to engineering development. Develop concepts for the Universal Bundle Airdrop System and conduct engineering design tests of the prototype Airdrop Controlled Exit System.



Program Element: #6.32.18.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Airdrop Equipment and Techniques  
Budget Activity: #2 - Advanced Technology Development

3. FY 1980 Planned Program: Acquire staging devices and conduct airdrop tests of Ultra High Level Container Airdrop System. Award multi-year contract for advanced development of an operational Ultra High Level Container Airdrop System. Fabricate and conduct feasibility tests of prototype Bundle Airdrop System unloading devices from the C-130 aircraft; initiate advanced development of Ground Assembly Aids with emphasis on fielding off-the-shelf or easily adaptable hardware to provide a near term, improved capability. Redesign and fabricate final test quantities of Airdrop Controlled Exit System for development and operational testing (DT I/OT I).
4. FY 1981 Planned Program: Complete advanced development of the Ultra-High Level Container Airdrop System. Complete feasibility tests from C-130 aircraft of Bundle Airdrop System unloading devices and enter engineering development for application to C-130 aircraft. Conduct military potential tests of candidate near term ground assembly aids and prepare Letter Requirement in preparation for entering engineering development; complete development and operational testing (DT I/OT I) of Airdrop Controlled Exit System from C-130 and C-141 aircraft; and initiate advanced development of High Level Platform Airdrop System and Heavy Drop Rigging System.
5. Program to Completion: This is a continuing program.

# FY 1980 RDT CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.33.06.A

DoD Mission Area: #234 - Guided Missiles and Rockets

Title: Terminal Homing Systems

Budget Activity: #2 - Advanced Technology Development

## A. RESOURCES (PROJECT LISTING): (\$ In thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total	
							Estimated Costs	Not Applicable
TOTAL FOR PROGRAM ELEMENT								
D236	Artillery Terminal Guidance	0	4100	9500	3000	Continuing	Not Applicable	

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** The Army has a need to accurately and economically attack tactical targets through the use of passive terminally guided munitions. The most pressing need in this area is a terminal guidance seeker capable of passively acquiring and guiding the ammunition to radio frequency (RF) emitting targets such as air defense radars, counter mortar/counterartillery radars and ground surveillance radars as well as command and control complexes. The seeker should be applicable to developmental guided projectiles (COPPERHEAD, 5-inch and 8-inch projectiles) and seeker componentry should be highly common with that of the developmental guided laser seekers for these projectiles. A second need exists for a terminal homing system, again for application to developmental guided projectiles, capable of acquiring and homing on the inherent electromagnetic signature of tactical targets such as in the infrared (IR) or millimeter wave (MMW) spectrums. Primary program thrust is the development of advanced seeker systems for terminally guided artillery munitions with minimum modification to the remainder of the munition. Principal effort will be development of a passive radio frequency (RF) seeker for future application to artillery delivered guided projectiles and initiation of development of an 8-inch guided artillery projectile for use with current and developmental seeker systems.

**C. BASIS FOR FY 1980 RDT REQUEST:** Initiation of development of an extended range 8-inch guided artillery projectile, utilizing previous Navy experience gained through their 8-inch guided projectile efforts, for use with current seeker systems as well as those seekers under development and evaluation within this program. Fabrication of radio-frequency (RF) seekers by competitive contractors for laboratory captive flight and firing tests of these seekers to determine their capability to acquire, track, and home on a variety of RF emitters (air defense radars, counter mortar and counterartillery radars, ground surveillance radars). Tests and analysis will also be conducted to determine the potential accuracy of these seekers and the effectiveness of the warheads of existing/developmental guided munitions given the expected accuracy. This effort will lead to selection of a baseline configuration for full-scale engineering development. Monitor current developments of infrared (IR) seekers for missile/projectile application for the attack of surface targets. The Army is currently re-examining this program to potentially reduce the FY 1979 programed level of effort in order to provide funds for higher priority tasks. Should the reduction be realized, the FY 1980 program will consist of reduced fabrication and testing of competitive seekers.

Program Element: #6.33.06.A  
 Title: Terminal Homing Systems  
 Budget Activity: #2 - Advanced Technology Development

and Mission Area: #234 - Guided Missiles and Rockets

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Not Applicable
RDIE						
Funds (as shown in FY 1979 submission)	0	4100	9405	Continuing		

FY 1980 funds have slightly increased over the FY 1979 submission due to the inclusion of the 8-inch guided projectile effort within this program. The cost of this additional effort has been largely offset by the restructuring of the advanced seeker development effort to provide greater competition within industry; more extensive in-house government participation; and, lower costs in FY 1980.

E. OTHER APPROPRIATION FUNDS: Not applicable.



Program Element: #6.33.06.A

DoD Mission Area: #234 - Guided Missiles and Rockets

Title: Terminal Homing Systems

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: A need exists to enhance the capabilities of field artillery units to enable passive attack (capability to home on the inherent signature of the target) of high priority targets at greater ranges. This program supports the examination and initial development of candidate passive homing technologies for application to terminally guided, indirect fire munitions. Primary emphasis has been placed upon the development of a radio-frequency (RF) seeker with the ability to acquire, discriminate and track radio-frequency emitters with sufficient accuracies to permit a high probability of single shot target kill. The primary targets for this type of engagement are air defense radars, artillery and mortar locating radars, and ground surveillance radars. Extension of the capabilities for the attack of command/control centers will be examined. Successful development of this seeker will permit the passive attack of these targets while maintaining maximum commonality with current semi-active laser guided munitions. This development will fully utilize the results and data of previous and current related efforts--particularly those for antiradiation missiles (ARM) and the Air Defense Suppression Missile (ADSM). A secondary effort in this program will be the adaptation of passive infra-red (IR) seekers, under development for missile/rocket application, for application to cannon/gun launched guided projectiles. The projectile IR seeker development will be fully coordinated with the Navy's IR seeker development for the 5-inch guided projectile which will be used in the surface-to-air role.

G. RELATED ACTIVITIES: Joint Development Program for the Army's COPPERHEAD, Program Element (PE) #6.46.21, and the Navy's 5-inch, PE #6.46.08.N, semi-active laser guided projectiles. The Army's position as Executive Service for the development of these munitions and coordination with the Navy's development community will preclude duplication of this effort among the Services.

H. WORK PERFORMED BY: In-house work is being performed by the US Army Missile Research and Development Command, Huntsville, AL, and the US Army Armaments Research and Development Command, Dover, NJ. Future effort will include the Naval Surface Weapons Center, Dahlgren, VA, and the Naval Weapons Center, China Lake, CA. Initial contracts for the competitive development of the IR seeker were awarded to General Dynamics, Pomona, CA, and Raytheon, Bedford, MA. Effort under these contracts was completed in FY 77.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: A detailed examination of the maturity and capabilities of alternate terminal homing technologies was completed in December 1976. Proposals by industry for the RF seeker were solicited, received, and evaluated. This effort was subsequently restructured to provide for greater competition within industry and greater government in-house participation. Competitive contracts for the fabrication and testing of an IR seeker were awarded to Raytheon and General Dynamics. This effort was completed in late FY 1977. Evaluation of these IR seekers was conducted in laboratory and captive flight tests by the US Army Missile Research and Development Command. Both prototypes demonstrated the ability to search, acquire, and track various infrared emitters; however, it was also demonstrated that reinforcement of the hardware performance was required.

Program Element: #6.13.06.A

DoD Mission Area: #234 - Guided Missiles and Rockets

Title: Terminal Homing Systems

Budget Activity: #2 - Advanced Technology Development

2. FY 1979 Program: Award competitive contracts to at least two contractors for design and fabrication of radio frequency (RF) seekers for captive flight and laboratory testing. These test results will lead to a determination of potential accuracies; adequacy of the airframe; and, effectiveness of the warhead of current and developmental guided munitions. The principal effort will be development of a new seeker while maintaining maximum commonality with the remaining portion of the applicable munition (projectile/rockets). The design and performance of developmental IR seekers will be examined for potential modification and application to guided projectiles (155 millimeter, 5-inch and 8-inch). The emphasis on the IR effort will be monitoring the current development efforts for IR seekers for potential projectile application while minimizing the modifications required to the basic projectile airframe, warhead, and control section.
3. FY 1980 Planned Program: Continue the fabrication of radio frequency (RF) seekers for application to the selected guided projectile airframe for detailed evaluation and testing and select the baseline configuration for full-scale engineering development. Initiate development of an extended range 8-inch guided projectile airframe for use with current and developmental seeker systems.
4. FY 1981 Planned Program: Conduct detailed evaluation, demonstration, and testing of RF seekers; transition the program to engineering development following successful flight testing.
5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.33.13.A

DoD Mission Area: #214 - Target Exploitation

Title: Missile/Rocket Components

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	3621	844	2100	2500	Continuing	Not Applicable
D087	Missile/Rocket Components	1468	0	0	0	0	13054
D142	Tri-Service Fire and Forget Active Radio Frequency (RF) Seeker	1349	0	0	0	0	1349
D691	Advanced Munitions	804	844	2100	2500	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides for feasibility demonstrations and research related to technology advancements in missile and rocket system components. The current effort concentrates on the investigation of methods for providing more effective nonnuclear antiarmor and antimaterial munitions for Army missiles and rockets. Prior year efforts have included: the development of a hemispheric coverage antenna for a 360-degree phased, array radar; determination of the storage reliability of missile and rocket components; and development of a tri-Service Active RF Seeker (TRI-FAST). This work is needed to provide the technological advances needed to maintain qualitative superiority in Army missile and rocket systems. It supports both evolutionary or modular improvements to existing systems and the development of new systems.

C. BASIS FOR FY 1980 RDT&E REQUEST: Funds are requested to continue the weaponization of an antiarmor munition to defeat future armor and to investigate methods of achieving increased effectiveness in the dispersion of submunitions. The latter work has potential application to emerging system concepts for the defeat of second echelon armor.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDT&E Funds (as shown in FY 1979 submission)	FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)			Additional to Completion	Total Estimated Cost	Not Applicable
	FY 1978	FY 1979	FY 1980			
	3677	1344	3400	Continuing		



Program Element: #6.33.13.A  
DoD Mission Area: #214 - Target Exploitation

Title: Missile/Rocket Components  
Budget Activity: #2 - Advanced Technology Development

FY 1979 variance reflects the Congressionally approved program versus the budget request. FY 1980 variance reflects a year's delay in initiating an effort to adapt the improved sensing munition (formerly designated sense and destroy antiarmor munition) for delivery by a missile system. This was done in consideration of funding constraints and the overall priority of this effort relative to other Army programs.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.33.13.A

Dob Mission Area: #214 - Target Exploitation

Title: Missile/Rocket Components

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: This program includes three projects: Missile/Rocket Components, tri-Service Fire and Forget Active Radio Frequency (RF) Seeker (TRI-FAST), and advanced munitions. Missile/Rocket Components encompasses two efforts. One effort focuses on the development of hemispheric coverage antenna (HCA) technology for a 360-degree phased array radar for advanced surface-to-air missile systems. A prototype hemispheric coverage antenna (HCA) has been designed, fabricated, and tested on an antenna test range under low power conditions. Storage reliability is a data collection and analysis effort to develop procedures and techniques to accurately predict the storage reliability of missile system components. A storage reliability data bank has been established. The tri-Service Active Radio Frequency (RF) Seeker (TRI-FAST) project is an effort to develop an all weather, fire and forget missile seeker for application to small (five and eight inch) surface-to-air and air-to-air missiles. Prototype seekers have been designed, fabricated, and tested. The current program contains no planned efforts on either Missile/Rocket components or TRI-FAST. The Advanced Munitions project is presently concentrated on the development of new and more lethal shaped charge mechanisms for defeating future armor and improved dispersion techniques for submunitions. Efforts in the subsequent years include the development of a target sensing munition for the attack of armored vehicles from the top.

G. RELATED ACTIVITIES: This Program Element (PE) is related to efforts conducted under Large Caliber and Nuclear Technology, PE 6.26.03, and Missile Technology, PE 6.23.03. There is no duplication of effort since these programs are oriented toward Exploratory Development while the projects conducted hereunder are Advanced Development efforts.

H. WORK PERFORMED BY: The US Army Armament Research and Development Command (ARRADCOM), Dover, NJ, has responsibility for executing the advanced munitions project. The Ballistics Research Laboratory, Aberdeen, MD, and the US Army Materiel Systems Analysis Agency, Aberdeen, MD, perform work assigned by ARRADCOM. Firestone Tire and Rubber Company, Akron, OH, is the contractor.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Hemispheric Coverage Antenna (HCA): This effort was initiated in FY 1974. A cost plus fixed fee contract was awarded to Sperry Gyroscope for the design, fabrication, and testing of the antenna. The design phase of the program was completed in FY 1975. Fabrication and assembly were completed in FY 1977 and FY 1978. A series of tests were conducted on the antenna in FY 1978 on the contractor's antenna test range to determine performance characteristics, including gain, sidelobe levels, and point accuracy. Storage Reliability: This effort was initiated in FY 1974. A computerized storage reliability data bank was established and updated on a continuing basis. Eighteen storage reliability data summary reports and a storage reliability parts count prediction handbook were published and widely distributed within Department of Defense and industry. Published storage failure rate data were utilized to accomplish storage reliability prediction on several systems to date including the Army's REDEYE, CHAPARRAL (Fuze and Seeker), and ROLAND short range air defense missile systems, the Army's HELLFIRE missile system, the Navy's TOMAHAWK, PRAM, and MARK 48 Torpedo systems and the Air Force's cruise missile system.

Program Element: #6.33.13.A

DoD Mission Area: #214 - Target Exploitation

Title: Missile/Rocket Components

Budget Activity: #2 - Advanced Technology Development

Accelerated testing of PATRIOT components to determine their storage reliability potential was completed and final reports published. A component storage reliability verification program on the COPPERHEAD (Cannon-Launched Guided Projectile) system was initiated. Real-time testing of several pools of stored components was accomplished (SPRINT, MINUTEMAN, Navy missile components). Lastly, a storage reliability seminar was held in May 1976 and a storage reliability workshop was conducted in May 1977. Tri-Service Active Radio Frequency (RF) Seeker (TRI-FAST): Prior to FY 1976, this was a Navy/Air Force project and was known as the Fast Acquisition, Search and Track (FAST) Program. In June 1976, a joint program under a tri-Service memorandum of agreement was established. A contract was awarded and tri-Service mentorship commenced. During FY 1977 the hardware design was completed, the fabrication of missile seeker hardware and test support hardware was completed, and system integration of the hardware was initiated. In FY 1978 five TRI-FAST seekers, including two 8-inch diameter and three 5-inch diameter were delivered and government testing completed. This testing included laboratory, fly-over, captive flight and shed tests. Advanced Munitions: This project was established in November 1969. Initial funding occurred in February 1971. Prior year efforts have included the investigation of dispersal techniques, combined effects, an antimaterial munition, an antiarmor bomblet, a munitions delivery system, and a focused blast warhead. During the past two fiscal years, the emphasis has been on development of a baseline shaped charge to defeat all known tank armors. In FY 1978, proven antiarmor lethal mechanisms from Exploratory Development were evaluated and feasibility for existing and future warhead designs was confirmed. Hardware was fabricated by Firestone Tire and Rubber Company and was tested with favorable results. Design efforts and fabrication research directed toward possibly providing an improved warhead for the TOW antiarmor missile system were performed.

2. FY 1979 Program: Advanced Munitions - Efforts will continue toward weaponizing proven lethal mechanism concepts for defeat of future armor. Test hardware fabricated in FY 1978 will undergo additional testing aimed at improving its performance. Warhead designs having potential application to the TOW system will be established. Fabrication research will continue toward achieving improved producibility and reduced production costs.

3. FY 1980 Planned Program: Advanced Munitions - Design research will be conducted for a munition to attack future armor from the top. Hardware will be fabricated and lethal mechanisms will be sled tested at the Naval Weapons Test Center, China Lake, CA. Submunition dispersion investigations using warhead spin up techniques will be initiated based upon results of parametric research being conducted under Exploratory Development in FY 1979. A hardware fabrication contract (contractor undetermined at present) will be placed for a feasibility demonstration of a specific warhead.

4. FY 1981 Planned Program: Advanced Munitions - The necessary testing to complete the development of improved lethal mechanisms for attack of armor from the top will be conducted. The result of this effort could support the development of advanced heavy and medium antiarmor missile system concepts and/or an improved TOW. Munition dispersion efforts will continue with demonstration firings using high spin warhead techniques to disperse cylindrical submunitions. Development will be initiated for an improved sensing munition (formerly sense and destroy antiarmor munition) capable of delivery by a missile system such as the General Support Rocket System or by a system designed for defeat of second echelon armor. This concept appears to offer promise as a low cost alternative for attack of armored vehicles from the top.



Program Element: #6.33.13.A

Dod Mission Area: #214 - Target Exploitation

Title: Missile/Rocket Components

Budget Activity: #2 - Advanced Technology Development

5. Program to Completion: This is a continuing program. Submunition dispersion based upon high speed warhead spinup will be demonstrated and made ready for application to new missile systems. Improved sensing munitions will be designed and feasibility established for application to existing or future missile systems.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.33.14.A

DoD Mission Area: #251 - Radiation Weapons Technology

Title: High Energy Laser (HEL) Components

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	13538	17292	19000	19286		Not Applicable
D093	High Energy Laser (HEL) Components	13538	17292	19000	19286	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program seeks expansion of the High Energy Laser (HEL) technology base, and exploration of potential use of the HEL in a weapon system for a variety of Army mission applications. The program is conducted in concert with the HEL programs of the Navy, Air Force, and the Defense Advanced Research Projects Agency (DARPA). Advanced Development (AD) prototypes for specific mission applications will be fabricated only after mission viability, system lethality, and technical feasibility have been established. The Army's most stressing potential application is vital assets from attack by precision guided munitions (PGM), especially antiradiation and electro-optic tactical air-to-surface. Another application being vigorously pursued is

C. BASIS FOR FY 1980 RDTE REQUEST: Continue development of one module of the Modular Army Demonstration System (MAIDS),

This technology is essential for a laser for the land warfare battlefield. Continue development of

Program Element: #6.33.14.A  
DoD Mission Area: #251 - Radiation Weapons Technology

Title: High Energy Laser (HEL) Components  
Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
NOTE Funds (as shown in FY 1979 submission)	13538	17292	19000	Continuing	Not Applicable

The funding profiles of the FY 1980 and FY 1979 Congressional Descriptive Summaries are the same.

E. OTHER APPROPRIATION FUNDS: Not applicable.



Program Element: #6.33.14.A  
DoD Mission Area: #251 - Radiation Weapons Technology  
Title: High Energy Laser (HEL) Components  
Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: A High Energy Laser Weapon System (HELWS) has several unique generic properties: Small beam divergence - a small spot of intense radiation can be precisely placed on small targets, or on a small vulnerable area of a large target; speed of light delivery - aiming error can be sensed immediately and corrected, and the target cannot evade the laser beam; short dwell time required to accumulate lethal damage - short engagement time; low fuel ("ammunition") consumption per shot - permits many shots to be stored on board. These properties give the HELWS a high potential

HELWS development includes the following areas: (1) the laser device - the beam generator; (2) beam control devices - the pointer/tracker which directs the beam precisely to the aimpoint; (3) propagation - study of the attenuation and distortion of the laser beam as it travels through the atmosphere, and compensation techniques to maximize energy delivery on target; and (4) damage effects and vulnerability.

G. RELATED ACTIVITIES: Complementary programs to expand the technology base and evaluate high energy laser potential are being conducted by the Army (Program Element (PE) 6.23.07.A, High Energy Laser Technology), Navy (PE 6.37.54.N, High Energy Laser), Air Force (PE 6.36.05.F, Advanced Radiation Technology and PE 6.26.01.F, Advanced Weapons), and the Defense Advanced Research Projects Agency (DARPA) (PE 6.23.01.E, Strategic Technology). The different battle environments and system platforms for each Service require significantly different HEL technology in fielded systems. The Service programs are closely coordinated by the Office of the Under Secretary of Defense (Research and Engineering). A number of the work efforts in the Department of Defense HEL program are jointly funded and performed. In prior years, Army HEL development has been funded under Program Element 6.21.38.01.A (High Energy Laser Research), 6.23.03.A (High Energy Laser Research), 6.26.03.A (High Energy Laser Research), 6.26.09.A (Project EIGHTH CARD), 6.26.12.A (Project EIGHTH CARD), 6.27.03.A (High Energy Laser Research), 6.27.05.A (High Energy Laser Research), 6.26.21.A (Laser Technology and Applications), and 6.36.11.A (High Energy Laser Development, Advanced Laser Development, and Project EIGHTH CARD).

H. WORK PERFORMED BY: The top five contractors are: AVCO Everett Research Laboratories, Everett, MA; TRW, Inc., Defense and Space Systems Group, Redondo Beach, CA; General Research Corporation, McLean, VA; Science Applications, Inc., La Jolla, CA; and General Electric Company, Philadelphia, PA. There are 19 additional contractors with an estimated total contract dollar value of \$4.9 million in FY 1979. Principal Army Government organizations conducting this development program are the High Energy Laser Center (Provo) and the US Army Missile Research and Development Command (MIRADCOM), Huntsville, AL. Additional work is being accomplished at other Government facilities, including the US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; Naval Research Laboratory, Washington, DC; the US Army Electronics Research and Development Command, Fort Monmouth, NJ; the White Sands Missile Range, NM; and the Lawrence Livermore Laboratories, Livermore, CA.

Program Element: #6.33.14.A  
DoD Mission Area: #251 - Radiation Weapons Technology

Title: High Energy Laser (HEL) Components  
Budget Activity: #2 - Advanced Technology Development

1. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Summary - Technologies necessary for High Energy Laser Weapons were identified and partially developed through research, subscale demonstrations, and selected scaling experiments. Systems studies established potential Army applications and advantages over alternate weapons.  
Laser Device Technology - The Army is responsible, within the Integrated Department of Defense (DOD)

Beam Control Device Technology -

Propagation/Effects/Lethality -

Program Element: 16.33.14.A

DoD Mission Area: 1251 - Radiation Weapons Technology

Title: High Energy Laser (HEL) Components  
Budget Activity: 12 - Advanced Technology Development

verifications were accomplished in a Joint Army/Navy program. First, a UH-1B helicopter was destroyed in November 1977 and then, MACH 1 TOM missiles in March 1978. Initial lethality  
Systems Analysis - The feasibility of HEL systems  
for air defense, ground-to-ground, and air-to-ground applications was established, and several point designs, such as were completed.

(MTU) -

Mobile Test Unit

2. FY 1979 Program: Summary - Emphasis will continue to be on

Laser Device Technology - Major emphasis will be on development of Laser Device Technology consistent with Army size, weight, and fieldability constraints. The program thrust will be the continued development of the Modular Army Demonstration System (MADS) module.

Beam Control Device Technology



Program Element: #6.33.14.A Title: High Energy Laser (HEL) Components  
DoD Mission Area: #251 - Radiation Weapons Technology Budget Activity: #2 - Advanced Technology Development

Propagation/Effects/Lethality - The major thrust of the propagation effort in FY 1979 is in three areas:

System Studies - Conceptual

designs and performance effectiveness studies will continue

3. FY 1980 Planned Program: Summary - The program's major focus will be on Laser System technology development.  
The primary thrust of beam control technology efforts will focus on the development of the

Laser Device Technology -

Beam Control Device Technology -

Propagation/Effects/Lethality -

Program Element: #6, 33, 14, A

DoD Mission Area: #251 - Radiation Weapons Technology

Title: High Energy Laser (HEL) Components  
Budget Activity: #2 - Advanced Technology Development

Systems Studies -

4. FY 1981 Planned Program: Summary - The primary thrust will be the complete testing of the Modular Army Demonstration System (MADS) I

Improved MADS I module

the basic laser/chemical pump. Effort will be initiated on the module which will incorporate an advanced chemical pump and totally solid reactant supply system. The totally solid reactant supply system includes oxidizer, fuel, and diluent supply subsystems. Advances in nozzle technology which have been demonstrated under the supporting technology program will also be incorporated. The upgrading and characterization of the Air Breathing Electric Laser (ABEL) will continue in preparation for the Army/Air Force Beam Control Device Technology -

Laser Device Technology - Complete the testing of the

effort will be the evaluation of

System Studies - After completion of the evaluation of the primary system design for an Advanced Development demonstrator.

Propagation/Effects/Lethality - The primary thrust of this

system definitions. effort will be initiated on a preliminary

5. Program to Completion: This is a continuing program. It is anticipated that

# FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.36.02.A Title: Advanced Land Mobility System Concepts  
DoD Mission Area: #239 - Land Mobility Technology Budget Activity: #2 - Advanced Technology Development

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978	FY 1979	FY 1980	FY 1981	Additional to Completion Continuing	Total
		Actual	Estimate	Estimate	Estimate		Estimated Costs
							Not Applicable
TOTAL FOR PROGRAM ELEMENT							
D118	Combat Vehicle Technology	2000	2000	1560	2100 <sup>1/</sup>	Continuing <sup>1/</sup>	Not Applicable
D188	High Survivability Test Vehicle	0	10000	14376	37686	Continuing	Not Applicable
D305	Advanced Anti-Armor Vehicle	0	3000	0	0	Continuing	Not Applicable

1/ Funding in FY81 and beyond provides for continued engineering efforts to develop a lightweight antiarmor vehicle and is based upon a favorable FY80 decision to proceed with such a development.

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The purpose of this program is to develop conceptual and experimental combat test bed vehicles. These conceptual test bed vehicles will incorporate new and advanced technology components that will enhance the ground mobility and combat effectiveness of combat vehicles. Conceptual vehicles employing advanced mobility concepts will be developed to determine feasibility. This program will alleviate many of the problems previously encountered in incorporating components representing new technology into system-oriented developmental vehicles. Continuation of this program will expand the combat vehicle technology base for exploitation by the Army. The joint program with the US Marine Corps and the Defense Advanced Research Projects Agency (DARPA) to explore lightweight combat vehicles is funded in this program.

C. BASIS FOR FY 1980 RDT&E REQUEST: Initiate testing of the High Survivability Test Vehicle-Lightweight (HSTV-L), a small, highly agile armored vehicle mounting an improved 75mm gun of excellent armor-piercing capabilities and a radically new approach to fire control/acquisition. This vehicle will weigh between 17-22 tons. The High Mobility/Agility test vehicle (HIMAC), a 33.5-45 ton variable component test bed built to examine the relationship between mobility and survivability will be extensively evaluated in field tests. The HIMAC has a test fixture 75mm gun. User testing is scheduled for completion in July 1980 at Fort Knox, KY, with an extensive test result analysis to follow. These evaluations will provide the data base for future combat vehicles. An elaborate data reduction and analysis program will provide cost effectiveness values for future decisions. Test firings of the 75mm guns from both the HSTV-L and HIMAC vehicles will provide a thorough knowledge of gun limitations and capabilities. This program will be jointly funded with the DARPA and the United States Marine Corps. International cooperative efforts in combat vehicle technology will be pursued. Two test vehicles, the Elevated Trunnion Concept Vehicle (ETCV) and the Loopwheel Test Bed (LTB) will be fabricated. The ETCV will evaluate the concept of a kinetic energy gun on an elevating mount permitting vehicle



Program Element: #6.36.02.A

Title: Advanced Land Mobility System Concepts  
Budget Activity: #2 - Advanced Technology Development

DoD Mission Area: #239 - Land Mobility Technology

and crew to remain in protected defilade while engaging targets. The Loopwheel Test Bed (LTB) is a revolutionary application of National Aeronautics and Space Administration (NASA) developed technology to combat vehicles offering a new suspension concept with reduced weight, fewer parts, lower life cycle costs, increased speed and agility, improved ride, and improved damage tolerance.

Major Milestones	Current Milestone Dates	Milestone Dates Shown in FY 1979 Submission
Completion of the High Survivability Test Vehicle-Lightweight (HSTV-L) fabrication	3QFY79	3QFY79
Complete testing of High Mobility/ Agility test vehicle (HIMAG) at Ft Knox, KY	3QFY80	3QFY80
Complete testing of HSTV-L at Ft Knox, KY	3QFY80	3QFY80
Complete fabrication elevated trunnion	2QFY81	--
Complete fabrication loopwheel test bed	2QFY82	--

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

ROUTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Not Applicable
	2000	22000	11704	Continuing		

FY/9 reduction due to Congressional elimination of \$7 million from the Program Element for North Atlantic Treaty Organization (NATO) Reliability, Survivability, and Interoperability (RSI) effort; per previous notification of Congress, D305 funds utilized in D188. The increase in FY80 is attributable to an increase in scope in the program reflecting not only the fabrication of the HSTV-L vehicle proper but the inclusion of the HIMAG vehicle, the 75mm guns and ammunition, and a complete test and analysis program to evaluate both vehicles, gun, and operational concepts.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.36.02.A  
DoD Mission Area: #239 - Land Mobility Technology

Title: Advanced Land Mobility System Concepts  
Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The Army has a continuing need to increase its ground combat vehicle technology base through examination of innovative concepts and unique weapons systems. While theoretical studies provide a great deal of information, it is mandatory that hardware test bed vehicles be fabricated which can be evaluated under actual field conditions. This program encompasses development and evaluation of experimental test bed vehicles incorporating the very latest technology and innovative concepts. The objective is to increase the mobility and combat effectiveness of future combat vehicles while decreasing developmental costs and time. The efforts conducted under this program will permit the exploration of revolutionary technology in test beds resulting in proven components and concepts to be incorporated in future Army combat vehicle systems. Continuous upgrading of the technology will enable the United States to maintain superiority over combat vehicles fielded by other countries. In a continuing program, concepts will be designed and fabricated to insure that chassis and weapon station components are available to meet forthcoming needs; and the effort of integrating these components into total systems will be assessed.

G. RELATED ACTIVITIES: Specific programs related to the technical areas of this program element (PE) are: PE 6.11.02.A, Project F22, Research in Vehicle Mobility; PE 6.21.05.A, Materials; PE 6.26.01.A, Tank Automotive Technology; PE 6.26.03.A, Large Caliber and Nuclear Technology; PE 6.27.33.A, Mobility Equipment Technology; PE 6.26.18.A, Ballistics Technology; PE 6.31.02.A, Materfels Scale-Up; PE 6.32.01.A, Aircraft Power Plants, Project 477, Demonstrator Engines; PE 6.26.08.A, Tank Gun Development and Tank Ammunition; PE 6.36.21.A, Combat Vehicle Power Trains; and PE 6.36.31.A, Combat Vehicle Turret and Chassis. Close relationship is maintained with other Services and Governmental agencies. Research and development information concerning combat, tactical, and special purpose vehicles is also being exchanged via data exchange agreements with allied countries. Close coordination prior to any budgetary decision is physically maintained and exchange of technical reports through the data exchange agreements is achieved. The High Survivability Test Vehicle-Lightweight (HSTV-L) is a joint program with the US Marine Corps and the Defense Advanced Research Projects Agency (DARPA).

H. WORK PERFORMED BY: Primary in-house efforts will be performed by the US Army Tank-Automotive Research and Development Command, Warren, MI. Other in-house efforts will be performed by the US Army's Armament Research and Development Command, Dover, NJ; Human Engineering Laboratory, Aberdeen, MD; Ballistics Research Laboratory, Aberdeen MD; Army Materiel Systems Analysis Agency, Aberdeen, MD; Waterways Experimentation Station, Vicksburg, MS; and US Army Armor Center, Fort Knox, KY. Contractors involved are: Aircraft Armaments, Incorporated (AAI), Baltimore, MD; National Water Lift, Kalamazoo, MI; Delco Corporation, Santa Barbara, CA; Hughes Aircraft Corporation, St. Louis, MO; Texas Instruments, Dallas, TX; BDM Corporation, Falls Church, VA; and Systems Planning Corporation (SPC), Arlington, VA.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

I. FY 1978 and Prior Accomplishments: Initiated fabrication of the HSTV-L. Initial concept feasibility work began on the Elevated Trunlon Concept Vehicle. Conducted the High Mobility/Agility test vehicle (HIMAG) chassis evaluation at Fort Knox, KY.

Program Element: #6.36.02.A  
DoD Mission Area: #239 - Land Mobility Technology

Title: Advanced Land Mobility System Concepts  
Budget Activity: #2 - Advanced Technology Development

2. FY 1979 Program: Complete fabrication, initiate testing and evaluation of the High Survivability Test Vehicle-Lightweight (HSTV-L). The High Mobility/Agility (HIMAG) test vehicle will continue testing and evaluation at Fort Knox, KY, and Aberdeen Proving Ground, MD, where the 75mm test fixture gun will be fired and evaluated. Analysis of test data provided by the HIMAG and HSTV-L vehicles will occur. Design studies of lightweight combat vehicle concepts for future consideration will occur. Began fabrication of the Elevated Trunnion Concept Vehicle (ETCV) and the Loopwheel Test Bed (LTB). The Loopwheel Test Bed will evaluate the feasibility of utilizing the loopwheel on combat vehicles in the 10-15 ton range as a continuation of the effort begun in 6.2 for a 3000 pound test bed.
3. FY 1980 Planned Program: The HSTV-L and HIMAG will complete testing and evaluation. Final report on HSTV-L program will be prepared and recommendations for future light armored vehicles will be provided. Requirements documentation for a future lightweight antiarmor vehicle will be prepared. Fabrication will be completed and evaluation initiated on the Elevated Trunnion Concept Vehicle. Fabrication of the Loopwheel Test Bed will continue.
4. FY 1981 Planned Program: Based on a favorable decision in FY80 to proceed with the development of a lightweight antiarmor vehicle, competitive contracts will be awarded for the fabrication of two advanced prototypes. Evaluation will continue on the Elevated Trunnion Concept Vehicle. Evaluation of the Loopwheel Test Bed will start.
5. Program to Completion: This is a continuing program.



FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #D188

Program Element: #6.36.02.A

DoD Mission Area: #239 - Land Mobility Technology

Title: High Survivability Test Vehicle

Title: Advanced Land Mobility System Concepts

Budget Activity: #2 - Advanced Technology Development

A. DETAILED BACKGROUND AND DESCRIPTION: This program supports a Joint Army, Defense Advanced Research Projects Agency (DARPA), and US Marine Corps program entitled "Armored Combat Vehicle Technology Program." The purpose of this joint program is to determine payoff for high levels of mobility and agility in combat vehicles, develop the 75mm gun initiated by DARPA, and examine the 75mm gun with concurrent ammunition developments combined with small, lightweight vehicles. Test bed vehicles are being fabricated and tested under this joint program. These vehicles include the High Survivability Test Vehicle-Lightweight (HSTV-L), a 17-22 ton test bed vehicle mounting on improved 75mm gun, and the High Mobility/Agility (HIMAG) test vehicle, a 33.5-45 ton variable parameter test bed vehicle mounting a test fixture 75mm gun. The test fixture gun can be fired either with high recoil forces or low recoil forces. The HIMAG is a rolling laboratory instrumented to provide extensive data on the fire control systems, human factors, vehicle suspensions, and other areas. The HSTV-L is a small, lightweight vehicle employing innovative design features to increase vehicle survivability. Advanced componentry is incorporated in both vehicles which will enable future vehicles to incorporate tested components. The program will culminate in FY 1980 with a recommendation on future development of a lightweight antiarmor vehicle.

B. RELATED ACTIVITIES: Program Elements (PE's): PE 6.26.01.A, Tank Automotive Technology; PE 6.26.03.A, Large Caliber and Nuclear Technology; PE 6.26.18.A; Ballistics Technology; PE 6.27.09.A, Night Vision Investigations; PE 6.27.16.A, Human Factors in Military Systems; PE 6.36.21.A, Combat Vehicle Power Trains; PE 6.57.02.A, Development Test Support, AMSAA; 6.57.12.A, User Test Support, OTEA; PE 6.57.04.A, RDTE Facilities, DARCOM.

C. WORK PERFORMED BY: In-house organizations participating in this program are: US Army Tank-Automotive Research and Development Command, Warren, MI; US Army Armament Research and Development Command, Dover, NJ; Waterways Experimentation Station, Vicksburg, MS; US Army Armor Center, Fort Knox, KY; Ballistic Research Laboratory, Aberdeen, MD; Marine Corps Development and Education Center, Quantico, VA; and US Army Infantry Center, Fort Benning, GA. Major contractors are: ARES Corporation, Fort Clinton, OH; Aircraft Armaments, Incorporated (AAL), Baltimore, MD; Texas Instruments, Dallas, TX; Delco, Goleta, CA; and National Water Lift Company, Kalamazoo, MI.

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Initiate fabrication of HSTV-L and conduct HIMAG chassis evaluation at Fort Knox, KY.
2. FY 1979 Program: Complete fabrication of the HSTV-L. Initial testing of the HSTV-L will begin at Fort Knox, KY. Testing will be conducted on the HIMAG vehicle with 75mm gun firings at Fort Knox, KY, and Aberdeen Proving Ground, MD. Data analysis will be conducted on data obtained from HIMAG vehicle and gun tests.

Project: #D188

Program Element: #6.36.02.A

DoD Mission Area: #239 - Land Mobility Technology

Title: High Survivability Test Vehicle

Title: Advanced Land Mobility System Concepts

Budget Activity: #2 - Advanced Technology Development

3. FY 1980 Planned Program: Initiate and complete testing of High Survivability Test Vehicle-Lightweight (HSTV-L) and complete High Mobility/Agility (HIMAC) testing. Data analysis will continue and the results derived will be presented in a final report on recommendations for development of light armored combat vehicles.

4. FY 1981 Planned Program: Based on a decision in FY 1980 to proceed with the development of a lightweight antiarmor vehicle, competitive contracts will be awarded at the beginning of FY 1981 for the fabrication of two each advanced prototypes.

5. Program to Completion: Test of the competitive prototypes will be conducted. An engineering development contract will be awarded. Development will be completed with an Initial Operability Capability (IOC) date projected for FY 1985.

6. Major Milestones:

Major Milestones	Current Milestone Dates		Milestone Dates Shown in FY 1979 Submission	
Contract award for HSTV-L fabrication Testing of HIMAC at Ft Knox, KY; Aberdeen Proving Ground, MD; and Ft Bliss, TX	2Q FY78		2Q FY78	
	4Q FY80		4Q FY80	
	4Q FY79		4Q FY79	
	1Q FY80		1Q FY80	
Complete fabrication of HSTV-L Begin testing of HSTV-L Complete testing of HSTV-L Interim report completed	4Q FY80		4Q FY80	
	1Q FY81		1Q FY81	

7. Resources (\$ in thousands):

RDT	FY 1978 Actual		FY 1979 Estimate		FY 1980 Estimate		FY 1981 Estimate		Additional to Completion		Total Estimated Cost	
Funds (current requirements)	0		10000		14376		37686		Continuing	27000	Not Applicable	
Funds (as shown in FY 1979 submission)	0		10000		4904		-				41904	

Project: #0188

Program Element: #6.36.02.A

DoD Mission Area: #239 - Land Mobility Technology

Title: High Survivability Test Vehicle

Title: Advanced Land Mobility System Concepts

Budget Activity: #2 - Advanced Technology Development

FY80 increased funding reflects increased scope of this program wherein the Army incorporated the HIMAG, HSTV-L, 75mm gun, increased lab support and data collection, reduction, and analysis effort under the Armored Combat Vehicle Technology Program.



FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.36.06.A

Title: Landmine Warfare  
Budget Activity: #2 - Advanced Technology Development

DoD Mission Area: #237 - Mines and Mine Countermeasures

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	1763	4690	2328	3995		Not Applicable
D006	Landmine Warfare	1763	4690	2328	3995	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** Provides for advanced development of components and concepts applicable to landmine warfare and the family of scatterable mines (FASCAM). Mines continue to provide a formidable obstacle to assist in overcoming the massive tank threat posed by the Warsaw Pact. Mines are required to fortify natural obstacles such as defiles, rivers, and built-up areas in order to delay, canalize, and interdict attacking forces and enhance the performance of direct and indirect fire weapons. Component efforts include improved sensors, fuzes, target discrimination logic and anticountermeasure devices to improve the overall effectiveness of mines and make minefields more difficult to traverse. New concepts include controllable minefields to allow for greater battlefield mobility of friendly troops, an off-route antitank mine for use along highways and roads and in built-up areas, and a river mine to enhance the obstacle potential of watercourses. Identified components, when integrated, will provide a system of mines and delivery means meeting Army requirements and compatible with systems being developed under Program Elements 6.36.23.A, Landmine Systems and 6.46.19.A, Landmine Warfare. New systems will complete Army requirements for a totally integrated mine-based barrier system.

**C. BASIS FOR FY 1980 RDTE REQUEST:** Continue efforts on improved lethal mechanisms, counter-countermeasure components, increased area mine system components, target signature analysis, controllable minefield components, and analysis of systems effectiveness.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion Continuing	Total Estimated Cost
	1813	8690	7157		Not Applicable

Program Element: #6.36.06.A  
DoD Mission Area: #237 - Mines and Mine Countermeasures

Title: Landmine Warfare  
Budget Activity: #2 - Advanced Technology Development

In FY 1979, the change reflects a Congressional reduction of \$4 million. As a result, the SLUMINE program has been deleted.  
The FY 1980 change reflects the creation of a new Program Element 6.36.23.A, Landmine Systems, to provide improved management of landmine resources and the movement of funds to higher priority Army requirements.

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.36.06.A

DoD Mission Area: #237 - Mines and Mine Countermeasures

Title: Landmine Warfare

Budget Activity: #2 - Advanced Technology Development

**F. DETAILED BACKGROUND AND DESCRIPTION:** The family of scatterable mines (FASCAM) is being developed utilizing baseline antitank and antipersonnel mines which can be replaced by a multiplicity of delivery means. The components of these mines perform necessary functions to insure that landmines continue to provide the battlefield deterrent commensurate with the changing nature of modern warfare. This objective is accomplished through new developments in mine sensing and discriminating logic, lethal mechanisms, fuzing, and improved resistance to enemy countermeasures. Efforts supported by this program are then integrated into ongoing and new mine hardware systems in Program Elements 6.36.23.A, Landmine Systems and 6.46.19.A, Landmine Warfare, in order to meet the requirements for Army barrier systems. In addition, this program supports efforts for new landmine warfare concepts and for the determination of concept feasibility. The long range goal of this program is to provide truly controllable barriers, highly lethal to enemy forces, while harmless to friendly troops.

**G. RELATED ACTIVITIES:** Systems advanced development for landmine systems is performed in Program Element 6.36.23.A, Landmine Systems. Engineering development of items and concepts in this program is performed in Program Element 6.46.19.A, Landmine Warfare. Developmental information is coordinated and exchanged between the Services by the Tri-Service Joint Technical Coordination Group for Bombs, Mines, and Clusters. The Department of Defense Armaments Munitions Requirements and Development Committee monitors the scatterable mine program with a view towards avoiding Service duplication. Countermine efforts under Program Elements 6.36.19.A and 6.46.12.A, Countermine and Barriers are reviewed on a continuing basis to incorporate necessary counter-countermeasures if applicable.

**H. WORK PERFORMED BY:** The Project Manager for Selected Ammunition, US Army Armament Research and Development Command (ARRADCOM), Dover, NJ; is responsible for management of Landmine Warfare systems and components. Other in-house efforts are provided by: The Army Materiel Systems Analysis Agency, Aberdeen, MD, and the US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA. Contractors include: Raytheon Company, Bedford, MA; Hughes Aircraft, Fullerton, CA; Sperry-Rand, Great Neck, Long Island, NY; Martin-Marietta, Orlando, FL; and Burroughs Corporation, Paoli, PA.

#### **I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

1. FY 1978 and Prior Accomplishments: Prior to FY 1975, helicopter delivered and artillery delivered antitank and antipersonnel mine systems were validated and moved into engineering development. Comprehensive systems effectiveness studies were conducted. Components for the Ground Emplaced Mine Scattering System (GEMSS) were developed. Power supplies and sensors were developed. In FY 1975, investigations on remote control components for minefield command arm/disarm were initiated. Systems effectiveness studies and component field tests continued. In FY 1976, studies continued on off-route and controllable mine systems. Design work on improved power sources and influence sensors were conducted. A prototype command and control module for scatterable mines was developed. During FY 1977, efforts were initiated on a microprocessor for mine sensor logic to assist in target discrimination and improve lethal probability. Advanced development on the Modular Pack Mine System (MPMS) was completed. Command and control functions for the employment of scatterable mines were categorized. A long stand-off sensing mechanism was investigated. During FY 1978, efforts continued on a microprocessor for mine sensor logic and on counter-countermeasures for antitank sensors. Work was initiated on improved lethal mechanisms and off-route mine components.



Program Element: #6.36.06.A  
DoD Mission Area: #237 - Mines and Mine Countermeasures

Title: Landmine Warfare  
Budget Activity: #2 - Advanced Technology Development

2. FY 1979 Program: Complete efforts on a microprocessor for mine sensor logic. Continue efforts on improved lethal mechanisms, counter-countermeasure components, increased area mine system components, target signature analysis, controllable minefield components, mine sensor components, and analysis of systems effectiveness.
3. FY 1980 Planned Program: Continue efforts on improved lethal mechanisms, counter-countermeasures components, target signature analysis, controllable minefield components, and analysis of systems effectiveness. Complete component efforts on increased area mine and mine sensor components. Initiate efforts on components for mines for use in built-up areas (MOBA).
4. FY 1981 Planned Program: Continue efforts on counter-countermeasure components, target signature analysis, systems effectiveness, and MOBA mines. Complete efforts on improved lethal mechanisms and controllable minefield components.
5. Program to Completion: This is a continuing program.

# FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.36.07.A Title: Army Small Arms Program  
DoD Mission Area: #235 - Guns and Related Technology Budget Activity: #2 - Advanced Technology Development

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
	TOTAL FOR PROGRAM ELEMENT	2065	215	500	0		
D627	Small Arms Components	695	0	0	0	Continuing	Not Applicable
D640	Light Machine Gun	1370	215	500	0	0	2085

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program encompasses all advanced development projects that support the Army Small Arms effort. The immediate objective of this program is the development of a lightweight, one-man Squad Automatic Weapon (SAW) which is capable of delivering a large volume of automatic, lethal, accurate, and sustained fire to correct an operational deficiency in the current small arms capability of the infantry squad.

C. BASIS FOR FY 1980 RDT&E REQUEST: Complete testing and conduct analysis and evaluation of data from development testing (DT I) and operational testing (OT I) on four Squad Automatic Weapon (SAW) candidates (MINIMI, Fabrique Nationale, Belgium; HK21A1, Hecklin & Koch, Germany; M248, Ford Aerospace and Communication Corporation, CA; and M16A1, Rifle Heavy Barrel Variant, US Army). Conduct an In-Process Review (IPR) to select the winning candidate for further development or procurement depending on the winning candidate.

Major Milestones	Current Milestone Dates	Milestone Dates Shown in FY 1979 Submission
Complete DT/OT I Testing In-Process Review	1Q FY 1980 2Q FY 1980	No milestones shown in FY 1979 budget submit

Program Element: #6.36.07.A  
DoD Mission Area: #235 - Guns and Related Technology

Title: Army Small Arms Program  
Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
RDTE Funds (as shown in FY 1979 submission)	695	215	250	Continuing	Not Applicable

Cost increases in FY 1978 and FY 1980 are due to the expansion of testing by including two additional Squad Automatic Weapon (SAW) candidate systems, the HK21A1 and the M16A1 Heavy Barrel Variant.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.36.07.A

DoD Mission Area: #235 - Guns and Related Technology

Title: Army Small Arms Program  
Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The Squad Automatic Weapon (SAW) program to evaluate caliber 5.56mm through 7.62mm was initiated in 1968 and progressed into Advanced Development (AD) in 1972. In 1974, the 6.0mm cartridge was selected as the optimum caliber for the SAW system weight and range requirements. In December 1974, all efforts on the 6.0mm cartridge were terminated in favor of using a cartridge design based on one of the standard calibers (5.56 or 7.62mm). During 1975-1976, feasibility studies were conducted to determine the SAW caliber and an improved 5.56mm round was developed to provide greater penetration at extended ranges. In 1977, a contract was awarded to Ford Aeronautics Communication Corporation for the fabrication of 18 prototype weapons based upon the design of the 6.0mm weapon for a side-by-side evaluation with the MINIMI weapon produced by Fabrique Nationale, Belgium. Both weapons were to fire the improved 5.56mm cartridge. In 1978, the SAW evaluation was expanded to include the HK21A1 weapon produced by Heckler & Koch, Germany, and the M16A1 Heavy Barrel Variant.

G. RELATED ACTIVITIES: This program represents the only source of Army small arms AD and is monitored by other Services. The development of the SAW is being coordinated with the NATO Small Arms Test funded under program element #6.48.06, NATO Small Arms.

H. WORK PERFORMED BY: In-house work is performed by the US Army Armament Research and Development Command (ARRADCOM), Dover, NJ, and the US Army Test and Evaluation Command (TECOM), Aberdeen Proving Ground, MD. Major contractors: Olin-Mathison Chemical Corporation, New Haven, CT; AAI Corporation, Cockeysville, MD; Maremont, Saco, ME; Ford Aerospace and Communications Corporation, Newport Beach, CA; General American Transportation (GATX), Chicago, IL; PRC System Sciences Corporation, Englewood Cliff, NJ; Heckler & Koch, Oberndorf, Federal Republic of Germany; and Fabrique Nationale, Herstal, Belgium.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

##### 1. FY 1978 and Prior Accomplishments:

a. Project D640 - Light Machine Gun. Parametric system studies identified a system that would meet the user's requirements. Through contractual and in-house efforts three US and two foreign mechanisms were submitted for user evaluation. The 5.56mm XM235 machine gun and the 5.56mm MINIMI machine gun developed by Fabrique Nationale, Belgium, were selected for further development. The cartridge used in the initial development was 6 millimeter. An improved 5.56mm ball projectile that extends helmet penetration range and a tracer that extends visible trace range were demonstrated. These two cartridges were submitted to the NATO small caliber evaluation as contenders for NATO standardization. The feasibility of converting the 6.0mm XM235 machine gun to 5.56mm millimeter was demonstrated. A program to demonstrate the SAW concept was developed and four candidate systems (MINIMI, Fabrique Nationale, Belgium; HK21A1, Heckler & Koch, Germany; M248, Ford Aerospace Communication Corporation, CA; and M16A1 Rifle, Heavy Barrel Variant) have been selected for testing in FY 1979.

Program Element: #6.36.07.A

BoD Mission Area: #235 - Guns and Related Technology

Title: Army Small Arms Program

Budget Activity: #2 - Advanced Technology Development

b. Project D013 - Infantry Weapon Systems. Low level light sight assemblies using promethium as illuminants were provided for the M16A1 rifle. Advanced technology was applied in designing and providing M16A1 rifles for user evaluation with muzzle compensation, burst control, and a single point (reflex collimator) sight.

c. Project D609 - Armor Machine Gun. A blank firing attachment (BFA) for recoil operating mechanisms was demonstrated and provided in limited quantities to support user evaluation and training programs. Evaluation and testing of US and foreign weapons identified the 7.62mm M60E2 machine gun and the Belgium MAG-58 machine gun as having the highest potential to meet the requirements for an interim armor machine gun. Comprehensive testing and evaluation of these two weapons was completed and the MAG-58 machine gun was selected as a replacement for the 7.62mm M219 machine gun presently used on various weapon systems.

d. Project D627 - Small Arms Components. Barrel wear and erosion investigations resulted in demonstrating significant improvement in the life of a rifle barrel. A chrome-plated, rotary swaged 4.32 millimeter barrel has demonstrated satisfactory performance through five thousand rounds. Thirty millimeter grenade cartridge and component configurations were developed and cartridges were provided to support weapon concept evaluation.

2. FY 1979 Program: Conduct development testing (DT) and operational testing (OT I) on four 5.56mm Squad Automatic Weapon (SAW) candidates. This schedule is based upon an anticipated reprogramming of approximately \$1.7 million dollars into the program in FY 1979.

3. FY 1980 Planned Program: Complete DT/OT I and conduct analysis and evaluation of test data to support an In-Process Review (IPR) to determine the future of the SAW.

4. FY 1981 Planned Program: Program to be determined by choice of winning SAW candidate and IPR recommendations for future development.

5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.36.13.A

DoD Mission Area: #235 - Guns and Related Technology

Title: Advanced Fuze Design

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING) (\$ in thousands)

Project Number	Title	TOTAL FOR PROGRAM ELEMENT	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs	
								Not Applicable	Not Applicable
DE 55	Advanced Artillery and Mortar Fuzing		535	510	1000	1705	Continuing		Not Applicable
DE 59	Supporting Advanced Fuze Development		290	312	571	407	Continuing		Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides for the development of advanced fuzing technology into prototype components, systems, and subsystems for artillery, mortar, aerial rockets, and tank ammunition. Primary goal is to increase operational effectiveness (e.g., lethality, reliability, flexibility) of present munitions, as well as improve mission cost-effectiveness. New technologies are being applied to improve existing components, such as impact switches, safety and arming devices, and power supplies to be utilized in all standard artillery and tank ammunition fuzes such as M739 PD, M742 APERS, M732 proximity and M509 base detonating fuzes. Wireless data transmission techniques are being developed to set fuzes (to a given range or function mode), thereby improving response time and reducing human error. A major objective is the development of new fuzes to meet the requirements of advanced weapons such as the artillery 200 second, batteryless electronic time fuze which does not require a setter, to supplement current time fuzes. New fuzes are needed for multiple warhead aerial rockets, guided and unguided artillery rounds, illuminating and smoke dispensing rockets, and mortar shells. Project DE 59, Supporting Advanced Fuze Development, supports this fuze development via improving techniques for testing fuzes and monitoring their operation, thereby reducing development time and cost. These advancements will contribute to increased weapon system operational capability, improved safety, increased effectiveness and lower costs.

C. BASIS FOR FY 1980 RDT&E REQUEST: Continue development of remote set fuzes for 2.75 inch rockets, tank fired ammunition and development of inductive proximity fuzes for a new multipurpose tank HEAT cartridge, the XM815. Initiate development of a highburst proximity artillery fuze and a low cost, battery-less, 200 second electronic time fuze for artillery. Continue development of telemetry systems for monitoring fuze component behavior in flight.



Program Element: #6.36.13.A  
DoD Mission Area: #235 - Guns and Related Technology

Title: Advanced Fuze Design  
Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Costs
Funds (as shown in FY 1979 submission)	825	822	1879	Continuing	No Applicable

Funds are reduced in FY 1980 as the scope of work in project DE 59 has been reduced.

E. OTHER APPROPRIATION FUNDS: Not Applicable

F. DETAILED BACKGROUND AND DESCRIPTION: The future effectiveness of antiarmor weapons is being challenged by the emergence of new improved armor. This threat not only demands new antitank weapons but also fuzing systems which function effectively in these new weapon systems at all angles of impact and without interference to warhead and weapon guidance system performance. The current program is investigating technology breakthroughs and impact antiarmor heat ammunition fuzing. A program will be initiated for a magnetic inductive technique which permits for improved HEAT multipurpose cartridges for 105mm and 120mm gun systems such as the XM815 and XM830 for the first time to sense stand-off by proximity regardless of the geometry of the ammunition nose. Triboluminescent films which permit all angle sensing with no mechanical interference or wires are being developed for tank HEAT cartridges. These and other techniques promise to counter the challenge of the threat represented in future armor warfare. A hit-burst artillery proximity fuze development is proceeding to assure capability for improved conventional munitions, extended range terminally guided projectile applications, and for smoke and illuminating mortar/artillery applications. Advances in electronic fuze technology now offer the opportunity to realize both hand-set and remote-set capability in electronic fuzing for artillery. The current program is exploiting this technology for the next generation 200-second, hand set, electronic time, artillery fuze. A program designed to lower the cost while improving impact sensitivity of these standard M739 point detonating (PD) fuze is in progress. A new low cost PD element is under development which will be incorporated into the M739 fuze in FY 1980. Remote set fuzing for tank fired ammunition against both ground and air targets is under investigation. This new capability will significantly lower reaction time and enhance tank survivability. Along these same lines is the development of remote set multioption 2.75" Rocket fuzing for helicopter systems. This development will also provide a substantial improvement in operational capability in terms of selecting from a single fuze the optimum fuze setting for maximum target effectiveness. In support of these fuze programs are developments to permit effective low cost evaluation of fuzes during development and to diagnose problems in production fuzes. A program is being initiated at Harry Diamond Laboratories to prove out and introduce new testing techniques into current and future fuze engineering activities. The program is aimed at obtaining a low cost, nose mounted telemetry system. Future plans call for development of techniques for measuring the more difficult fuze environments and response to in-bore launch and terminal impact. The program will convert existing technology into practical tools for engineering and development during fuze development programs and malfunction investigations.

Program Element: #6.36.13.A

DoD Mission Area: #235 - Guns and Related Technology

Title: Advanced Fuze Design

Budget Activity: #2 - Advanced Technology Development

G. RELATED ACTIVITIES: This program supports the development of fuzing to meet the requirements of munitions funded by the following program elements: 6.46.01.A, Lightweight Company Mortar System; 6.36.08.A/6.46.02.A, Weapons and Ammunition. Projects in this program are supported by exploratory development programs 6.26.03, Large Caliber and Nuclear Technology. Developments in this program are compatible with Tri-Service requirements to avoid proliferation of RDTE programs. All new programs are coordinated with joint technical coordinating groups.

H. WORK PERFORMED BY: In-house agencies: Harry Diamond Laboratories, Adelphi, MD; US Army Electronics Research and Development Command, Adelphi, MD; US Army Armament Research and Development Command, Dover, NJ; US Army Armament Readiness Command, Rock Island, IL; and US Army Test and Evaluation Command, Aberdeen Proving Ground, MD. Contractors will include General Electric Company, Burlington, VT and Syracuse, NY.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Advanced development of a multi-option fuze (selectable functions include high and low air burst, impact, and delayed function after impact) for 60mm and 81mm mortars was completed. This fuze has since completed all development, and is now scheduled for production. A beehive fuze (for releasing nail-like submissiles), advanced to full scale development. High explosive antitank fuzes in stockpile were modified following improvements developed in this program. A task to develop a nonchemical, air-driven, power source resulted in the adaptation of this concept into several fuze developments. Transmitter hardware for the remote set fuze for tank ammunition was evaluated. Final ballistic tests were completed on the XM443/XM444 remote set fuzes for the 2.75 rocket system. A program for development of a magnetic inductive proximity antiarmor fuze was initiated. This program stems from the magnetic technology gained within the exploratory development program for proximity sensing metal targets while being immune to brush and other nonferrous targets.
2. FY 1979 Planned Program: Efforts will be conducted to evaluate prototype remote set tank ammunition fuzes. The investigation pertinent to the point detonating element for the M739 fuze will be completed. Design efforts will be initiated for a 200 second electronic time fuze for artillery ammunition. Development effort for a hi-burst proximity fuze will be initiated. A bread board model of the inductive fuze will be fabricated to evaluate unique configurations and sensing techniques. 6.2 technology will transition into an advanced development program for a film coating technique to be utilized in the development of a fuze for antiarmor type ammunition. The effort on nose mounted telemetry will be continued.
3. FY 1980 Planned Program: The efforts on the impact sensor for the M739 fuze for artillery ammunition will have been completed, and transferred into a product improvement program for repackaging the components within the M739. The remainder of the programs discussed for FY 1979 will continue through FY 1980-81. The transducer calibration program will continue. The requirements for both impact and in-bore telemetry will be established and design concepts initiated. Design will be initiated for laboratory type equipment for evaluation of sensitivity of point detonating and point initiating-base detonating elements for fuzes used on antiarmor type ammunition.

Program Element: #6.36.13.A

DoD Mission Area: #235 - Guns and Related Technology

Title: Advanced Fuze Design

Budget Activity: #2 - Advanced Technology Development

4. FY 1981 Planned Program: Continue development of the tank remote set and proximity fuze, 200 second artillery electronic time fuzes, and hi-burst artillery proximity fuzes.
5. Program to Completion: This is a continuing program.



FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6, 36, 18, A

DoD Mission Area: #237 - Mines and Mine Countermeasures

Title: Countermine and Barrier Development  
Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs	Not Applicable
	TOTAL FOR PROGRAM ELEMENT	1098	2024	2859	4935			
D608	Countermine and Barrier Development	1098	2024	2859	4935	Continuing		Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Soviet and WARSAW PACT doctrine advocates the large scale use of landmines in both offensive and defensive operations. In support of this doctrine, the Soviets have developed mechanized devices which rapidly lay with minefields having a variety of complex mine fuzes. Mutually supporting countermine devices and techniques are required to meet the threat. The objective of this program element is to improve the Army Countermine capabilities by investigating and exploiting materials, techniques, and equipment evolving from exploratory development. These investigations will ultimately lead to enhanced tactical mobility by neutralizing the barrier potential of enemy minefields. Additionally, concepts on advanced barrier techniques to reduce the logistics burden normally associated with barrier systems are investigated in the component mode and those which appear promising are advanced to the systems phase. A comprehensive system of barriers is required to significantly reduce the capabilities of massed Soviet armored forces. Improved field fortifications techniques are devised and evaluated to improve battlefield survivability of friendly forces by hardening tactical positions. This is necessitated by improved threat munitions effectiveness.

C. BASIS FOR FY 1980 RDTE REQUEST: Complete advanced technology efforts on vehicle component hardening to resist mine damage, improved fuel-air explosives (IFAE) for improved mine neutralization, and improved tactical shelters. Continue efforts on a minefield breach widening and clearance proofing trailer to support breaches by rollers and/or plows. Initiate advanced development on improved pyrophoric particles and a dedicated countermine vehicle as long range efforts to counter the minefield threat.

Program Element: #6,36,18.A

DoD Mission Area: #237 - Mines and Mine Countermeasures

Title: Countermine and Barriers Development  
Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>	<u>Additional to Completion</u>	<u>Total Estimated Cost</u>
RDTE					
Funds (as shown in FY 1979 submission)*	1685	2008	2633	Continuing	Not Applicable

In FY 1978, reduction reflects movement of funds to higher priority Army projects. In FY 1979, change reflects minor adjustments.  
In FY 1980, increase represents a minor cost estimate adjustment based on availability of better cost data.

\* In FY 1979 submission, this profile was shown in Program Element 6.36.19.A/b608.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.36.18.A

DoD Mission Area: #237 - Mines and Mine Countermeasures

Title: Countermine and Barriers Development

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: This program contains tasks designed to provide the Army with a family of mutually supporting countermine devices and techniques to meet the identified threat. Mine detection and neutralization are examined based on tactical scenarios and conditions and translated into prototype developmental items by exploiting technology achieved during Exploratory Development. The challenge of mine detection and neutralization has proven to be highly complex if the momentum of the attack is to be maintained. Detection thrust has transitioned from the meticulous point-to-point search to methods of detecting minefields from standoff locations. Neutralization has been redirected from a slow defuzing process to one of rapid neutralization by explosives or hardened components. Surface Launched Unit Fuel Air Explosive (SLUFAE) introduced the first potential for standoff neutralization. Barrier efforts are being directed towards the use of the most advanced technology to deny or reduce enemy mobility on the battlefield with a goal of a ten-fold reduction in barrier system logistics. Field fortifications equipment and techniques are employed for the purpose of increasing the survivability of friendly forces.

G. RELATED ACTIVITIES: Exploratory development for this program is conducted in Program Element 6.27.33.A, Mobility Equipment Technology. Further development efforts which result from this program are accomplished in Program Elements 6.46.12.A, Countermine and Barriers, and 6.36.19.A, Countermine and Barriers. Countermine efforts are closely coordinated with the Project Manager for Selected Ammunition, Dover, NJ, who is responsible for the Army Mine Program.

H. WORK PERFORMED BY: The US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, is assigned responsibility for Countermine and Barriers. In-house efforts are performed by the US Army Test and Evaluation Command, Aberdeen, MD. Contractors include; Chrysler Corporation, Detroit, MI; Goodyear Aerospace, Akron, OH; Honeywell Incorporated, Hopkins, MN; Cubic Corporation, LaJolla, CA; and Martin-Marietta, Orlando, FL.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: In the area of mine detection, the potential of pulse radar, X-ray and gamma ray excitation, passive infrared devices, microwave techniques, and trace gas detection devices were evaluated. The ability of dogs to detect the explosives in landmines and booby traps was demonstrated and a mine mine detection manual was completed. A prototype evaluation of the vehicle mounted road mine detector was conducted. In mine neutralization, fuel-air explosives (FAE) were shown to be an effective minefield clearance device. During FY 1977, tests were conducted on components of the mine clearing roller on an expedited basis. In FY 1978, work was initiated on a portable, projected line charge for antipersonnel minefields and hardening of vehicle components to resist mine damage. Advanced development of an overhead cover for the TOW (tube-launched, optically tracked, wire guided antitank missile) was initiated.

2. FY 1979 Program: Initiate efforts on a minefield breach widening and proofing trailer intended to expand lanes created by the mine clearing roller and other devices. Continue efforts on vehicle component hardening, improved fuel-air explosives, improved tactical shelters and the TOW shelter.

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Program Element: #6.36.18.A  
DoD Mission Area: #237 - Mines and Mine Countermeasures

Title: Countermine and Barriers Development  
Budget Activity: #2 - Advanced Technology Development

3. FY 1980 Planned Program: Continue efforts on a minefield breach widening and proofing trailer. Complete advance technology efforts on vehicle component hardening, improved fuel-air explosives, and improved tactical shelters. Initiate advanced development on pyrophorics and a dedicated countermine vehicle.

4. FY 1981 Planned Program: Continue efforts on improved countermine concepts, techniques, and components. Continue efforts on advanced tactical barriers and improved field fortifications.

5. Program to Completion: This is a continuing program.

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DEPUTY CHIEF OF STAFF FOR RESEARCH DEVELOPMENT AND AC--ETC F/G 5/1  
DESCRIPTIVE SUMMARIES FOR PROGRAM ELEMENTS OF THE RESEARCH, DEV--ETC(U)  
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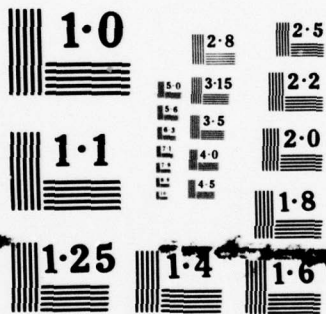
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FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.36.21.A

DoD Mission Area: #239 - Land Mobility Technology

Title: Combat Vehicle Propulsion Systems

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>2713</b>	<b>5700</b>	<b>3816</b>	<b>7000</b>		<b>Not Applicable</b>
D007	Combat Vehicle Engine	2162	4900	2516	5000	Continuing	Not Applicable
DJ95	Combat Vehicle Transmission	551	700	1300	2000	Continuing	Not Applicable
A561	Energy Conservation	0	100	0	0	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides for advanced technology demonstration of combat vehicle propulsion components not available in commercial form. Combat vehicles require high output, low volume/weight, multifuel, efficient and durable engines not normally available on the commercial market. Ancillary components, such as air filtration and cooling systems must be provided for the propulsion systems to enable them to operate in a unique military environment. This program also provides funding to develop combat vehicle transmissions necessary to provide greater vehicle responsiveness for increased survivability and performance.

C. BASIS FOR FY 1980 RDT&E REQUEST: Initiate advanced development of Adiabatic Diesel engine to provide fuel efficient, compact, lightweight diesels for the lightweight class of combat vehicles which will provide much higher levels of mobility and agility than do current vehicles. Complete the development effort of the components for the ACT-1500 horsepower turbine to improve fuel economy. Increase the effort on developing efficient self-cleaning air cleaners for high output turbines and diesels. New technology will be incorporated into turbine and diesel components, which will greatly increase efficiency and reduce energy consumption. Provide for the continued development of the CVX-650 hydromechanical transmission for application in combat vehicles up to 25 tons and 750 gross horsepower with a 9% fuel savings.

Major Milestones

Complete Laboratory Testing of 1st Adiabatic Demonstrator Engine  
 Complete Fabrication of Initial CVX650 Transmission  
 Begin Testing of CVX650  
 Complete Assembly of 1st Prototype Fuel Efficient ACT-1500 Gas Turbine

Current Milestone Dates	Milestone Dates Shown in FY 1979 Submission
4QFY 1981	Not Shown
4QFY 1981	Not Shown
1QFY 1982	Not Shown
2QFY 1980	Not Shown

Program Element: #6.36.21.A  
DoD Mission Area: #239 - Land Mobility Technology

Title: Combat Vehicle Propulsion Systems  
Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
RDTE Funds (as shown in FY 1979 submission)	3529	3051	6600	Continuing	Not Applicable

Differences between the FY 1980 and FY 1979 Congressional Descriptive Summaries are due to the Congressional addition of \$3.0 million in FY 1979 for work on an advanced 1500 horsepower diesel engine and the transfer of other combat vehicle components efforts from this Program Element (PE) to PE 6.36.31, Combat Vehicle Turret and Chassis. The decrease in FY 1978 results from the reprogramming of funds to other higher priority programs. The decrease in FY 1980 results also from the reallocation of funds to higher priority programs.

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.36.21.A

DoD Mission Area: #239 - Land Mobility Technology

Title: Combat Vehicle Propulsion Systems

Budget Activity: #2 - Advanced Technology Development

**F. DETAILED BACKGROUND AND DESCRIPTION:** Effective ground combat vehicles must be able to move rapidly with a high degree of reliability. This program provides for the technology demonstration of those combat vehicle components not commercially available. The unique requirement of military vehicles for extremely high output and efficiency dictate that propulsion systems and other components be developed by the Government or under Government auspices. To ensure that such components are available for integration into future and present ground combat vehicles, vehicle power train components are developed within this program. The program's goals are to develop for future combat and other ground vehicles those components that will: (1) increase fuel tolerance; (2) improve fuel economy; (3) improve horsepower-per-ton ratio; (4) improve compactness; and (5) improve maintenance, reliability, and availability of vehicle components.

**G. RELATED ACTIVITIES:** Program Elements (PE): PE 6.26.01.A, Tank and Automotive Technology; PE 6.36.02.A, Advanced Land Mobility Systems Components; PE 6.21.03.A, Materials; PE 6.27.33.A, Mobility Equipment Technology; PE 6.32.01.A, Aircraft Power Plants and Propulsion; PE 6.31.09, Fuels and Lubricates Advanced Development; and PE 6.31.02.A, Materials Scaleup. Foreign state-of-the-art trends in military propulsion systems are constantly monitored by the Tank-Automotive Research and Development Command, and data are exchanged with allied countries via data exchange agreements. Close coordination with any budgetary decision is physically accomplished to preclude duplication of efforts with other Services.

**H. WORK PERFORMED BY:** US Army Tank-Automotive Research and Development Command, Warren, MI, is responsible for the development of this program. Major contractors are: Teledyne Continental Motors, Muskegon, MI; AVCO Lycoming, Stratford, CT; Donaldson Corporation, Minneapolis, MN; Cummins Engine Company, Columbus, IN; Detroit Diesel Allison, Indianapolis, IN; General Electric, Pittsfield, MA; and PWC, San Jose, CA.

#### **I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

1. **FY 1978 and Prior Accomplishments:** Improvement of the 1500 horsepower gas turbine was initiated to increase efficiency and fuel economy. Fabrication of a high output 1000 horsepower (hp) advanced diesel engine for medium weight close combat vehicles was initiated. A contract was executed for the development of a self-cleaning air cleaner for use with the higher air flow engines such as the 1500 horsepower gas turbine. A development program was initiated for a continuously variable cross drive hydromechanical transmission (CVX650) in the 650 horsepower range. This transmission is slated for vehicles up to 25 tons with mobility requirements equivalent to or better than the XM1.

2. **FY 1979 Program:** Award a contract for a 1500 hp Advanced Diesel Program in accordance with guidance provided by the Congress. This program provides for design improvements for the variable area turbocharger and the development of a modulated cooling fan system. Continue work on the ACT-1500 hp gas turbine fuel economy. Complete design, fabricate, and initiate contractor testing of a self-cleaning filtration system for the 1500 hp turbine. Develop hydraulic pump, motors, and electronic control components for the CVX500 transmission. Initiate component development work on the AMX(1000) hydrokinetic transmission. This transmission is in the 900-1100 hp range for vehicles in the 30-45 ton weight class.



Program Element: #6.36.21.A  
DoD Mission Area: #239 - Land Mobility Technology

Title: Combat Vehicle Propulsion Systems  
Budget Activity: #2 - Advanced Technology Development

3. FY 1980 Planned Program: Initiate advanced development of an experimental prototype Adiabatic Diesel engine at a nominal 700 horsepower (hp) for the light class of combat vehicles. Complete component rig testing of AGT-1500 hp turbine fuel economy modifications and initiate assembly of two complete turbines for performance demonstration and endurance testing. Fabricate preproduction versions of self-cleaning air cleaners and carry-out bench testing as well as vehicle installation for field testing. CVX-650 hydromechanical transmission effort will consist of component testing and design, and test of the breadboard electronic controller, shaft selector, electric valve bodies, and diagnostic equipment. Component development and design will continue on the hydrokinetic transmission (the AMX-1000).
4. FY 1981 Planned Program: Continue advanced development (AD) of prototype Adiabatic Diesel engine including dynamometer testing. Also, initiate fabrication and assembly of advanced prototype engines for continuing development of the Adiabatic Diesel Engine. Complete the AGT-1500 gas turbine fuel economy development program. Work will be completed on a self-cleaning air cleaner. The prototype hydromechanical transmissions (CVX650) will be built and assembled. Laboratory tests will be initiated and a tracked vehicle modified for transmission installation. Final design for the new hydrokinetic transmission, AMX-1000, will be completed.
5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.36.31.A

DOD Mission Area: #239 - Land Mobility Technology

Title: Combat Vehicle Turret & Chassis  
Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>2126</b>	<b>351</b>	<b>3732</b>	<b>8557</b>		<b>Not Applicable</b>
D014	Combat Vehicle Hull & Turret	0	0	2132	5617	Continuing	Not Applicable
D424	Combat Vehicle Track & Suspension	2126	351	1600	2940	Continuing	Not Applicable
A561	Energy Conservation						

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The program provides for advanced technical demonstration of components associated with ground combat vehicle hulls, turrets, track and suspension subsystems that are not commercially available. The primary areas of development include: improved combat vehicle fire detection and suppression systems which will significantly reduce the casualty loss of crew and vehicle, and improve the repair turnaround time for the vehicle to return to battle; consolidation of electrical power management within the vehicle which will greatly improve vehicle performance, maintainability, and simplify crew and operator training; the integration of state-of-the-art fire control and vehicle positioning technology which will provide higher hit/kill performance, simplify crew training and improve maintenance; improved track design and suspension to provide armored vehicles with high mobility, improved reliability, simplified maintainability, and overall reduction in weight and energy drive loss; and the incorporation of countermeasures and defense mechanisms against air and ground launched antitank threats.

C. BASIS FOR FY 1980 RDT&E REQUEST: Work will be initiated to provide near term target acquisition/fire control systems and vehicle positioning systems for combat vehicles which represents the latest state-of-the-art fire control technology. The development of fire detection and suppression technology will be expedited to demonstrate the capability of extinguishing combat vehicle fires within 100 milliseconds after ignition. An optical sensor system will be utilized with Halon 1301 suppressing agent for application to tanks, and other combat vehicles. The track and suspension program will provide at least 25% improvement in reliability, traction, and survivability by applying state-of-the-art breakthroughs in materials and track and suspension technology. The suppression of infrared and acoustic signatures to counter the seekers/sensors of antitank guided missile threats will be demonstrated.

Program Element: #6.36.31.A  
DoD Mission Area: #239 - Land Mobility Technology

Title: Combat Vehicle Turret & Chassis  
Budget Activity: #2 - Advanced Technology Development

Major Milestones	Current Milestone Dates	Milestone Dates Shown in FY 1979 Submission
Fire Detection and Suppression System -		
Start Testing	4QFY79	None Shown in FY 1979 submission
Complete Test	2QFY80	
Advanced Track -		
Initiate Initial Testing of Advanced Track	3QFY79	
Complete Initial Testing of Advanced Track	2QFY80	
Advanced Techniques for Electrical Power Systems -		
Start Testing	1QFY81	
Advanced Fire Control -		
Initiate Design	3QFY80	
Complete Design	4QFY82	

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
NOTE					
Funds (as shown in FY 1979 submission)	-	-	-	-	-

This is a new Program Element resulting from a restructuring of activities. Previous program activities were accomplished as part of Program Element 6.36.21, Combat Vehicle Power Trains.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.36.31.A

DoD Mission Area: #239 - Land Mobility Technology

Title: Combat Vehicle Turret & Chassis

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: To be effective on the battlefield, ground combat vehicle design must incorporate the state-of-the-art technology to maintain technical superiority and win the first battle. This program encompasses projects and tasks which provide the subsystems and components leading to the improvements necessary to meet this objective. Results from this program will be applied to existing combat vehicles and incorporated into designs of future combat vehicles.

1. The fire detection and suppression program was initiated to enhance personnel and vehicle protection against catastrophic fires resulting from ballistic penetration. Battle damage assessment reports from Southeast Asia and the Mideast have shown extensive crew fatalities and vehicle losses resulting from fires caused by penetration which did not initially kill the vehicle or crew. The current effort will standardize a fire suppression system to detect and extinguish fires within 100 milliseconds after ignition. This will result in a significant reduction of crew casualties as well as fewer vehicle losses.

2. State-of-the-art fire control sighting, tracking, vehicle positioning, and environmental sensing elements will be integrated into prototype hardware for enhancing the rapid servicing of targets at extended ranges, on the move and in all-weather battlefield environments. The integration program will assure that relevant technology projects are developed and that components are integrated early into the combat vehicle's development cycle to provide maximum utilization of components, functions, space, and weight.

3. Combat vehicle electrical power requirements have doubled in recent years resulting in increased system complexity and reduced overall reliability. Advanced Techniques for Electrical Power Systems (ATEPS) will provide a simple multiplex system which will greatly reduce the number of electrical harnesses and connectors in a combat vehicle's electrical system. This new system will be significantly easier to trouble shoot and maintain and will greatly improve system reliability.

4. Currently over \$200 million annually is expended on the replacement of track and suspension parts. Technology is available which can reduce this annual cost. The increased speeds and mobility of future combat vehicles required more durable and reliable track and suspension systems. This program will develop both light and heavy vehicle class track using new materials and technologies for replacement on current combat vehicles and for use on future combat vehicles.

5. The advances in signature suppression and threat detection technology make it possible to significantly reduce the probability of detection by and the effective range of antitank guided missiles. It is feasible to incorporate threat warning and reaction devices for ground vehicle protection by adapting similar devices now being developed for aircraft protection and integrating these devices with the ground vehicle's reaction capabilities such as the vehicle armament and/or smoke deployment. The achievement of the objectives of this effort will provide ground combat vehicles with components enhancing increased battlefield survivability by reducing the probability of detection and by reducing the probability of hit if detected.

Program Element: #6.36.31.A  
DoD Mission Area: #239 - Land Mobility Technology

Title: Combat Vehicle Turret & Chassis  
Budget Activity: #2 - Advanced Technology Development

G. RELATED ACTIVITIES: Program Elements (PE): PE 6.21.05.A, Materials; PE 6.31.02.A, Materials Scaleup; PE 6.21.20.A, Nuclear Weapons Effects/Fluidics; PE 6.26.01.A, Tank Automotive Technology; PE 6.36.02.A, Advanced Land Mobility System Concepts; PE 6.26.17.A, Small Caliber and Fire Control Technology; PE 6.27.09.A, Night Vision Investigations; PE 6.27.16.A, Human Factors in Military Systems; and PE 6.26.18.A, Ballistics Technology. Foreign state-of-the-art trends in military propulsion systems are monitored by TARADCOM and technology information exchanged with allied countries via data exchange agreements. Close coordination with any budgetary decision is physically accomplished to preclude duplication of efforts with other Services. Joint programs are also being pursued with the US Air Force and the US Navy to adapt techniques used for the reduction of aircraft and missile vulnerability to ground combat vehicle use.

H. WORK PERFORMED BY: The Army Tank-Automotive Research and Development Command, Warren, MI, is responsible for the development and system integration of this program. Major contractors for the program elements include Chrysler, Huntsville Electronics Division, Huntsville, AL, and System Consultants, Inc., Dayton, OH, Santa Barbara Research Center, Goleta, CA; Marotta Scientific Controls, Inc., Boonton, NJ; Gravier Corp., Mountaintop, NJ; HTL, Monrovia, CA; FAA, Atlantic City, NJ; FMC, San Jose, CA; National Water Lift Co., Kalamazoo, MI; Chrysler Corp., Detroit, MI; Standard Products Co., Fort Clinton, OH; Goodyear Tire and Rubber Co., St. Mary's, OH; and Firestone, Noblesville, IN.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Fabrication of samples of long life, low maintenance track was completed. Advanced track and suspension components were examined on the High Mobility/Agility (HIMAC) test vehicle.
2. FY 1979 Program: The fabrication of an Advanced Techniques for Electrical Power Systems (ATEPS) prototype hardware to demonstrate its feasibility for XM1 tank will be initiated. Field and laboratory testing of the long life, low maintenance track samples will be conducted. Fabrication of controlled dampers will be initiated. Specifications will be finalized for the fire detection and suppression system. Test fixtures to evaluate this system will be designed and fabricated. The funding level will be increased in FY 1979 to support this program.
3. FY 1980 Planned Program: Initiate integration of fire control components and subsystems into a demonstratable near term target acquisition fire control system. The target acquisition fire control system is comprised of high potential sighting, tracking, and environmental sensing components with application to several combat vehicles. Testing of the fire detection and suppression system to assess system performance. Dispersion efficiency, false alarm, and slow growth fire detection will be tested to establish threshold characteristics for military specifications. Prototype hardware development for ATEPS will continue with software development and component integration for specific combat vehicle installation efforts. Field and laboratory testing of long life, low maintenance track will be completed. Initiate evaluation of controlled dampers and fabricate an

Program Element: #6.36.31.A

DoD Mission Area: #239 - Land Mobility Technology

Title: Combat Vehicle Turret & Chassis

Budget Activity: #2 - Advanced Technology Development

Independent external suspension system for combat vehicles. Components for acoustic detection of attack helicopters will be fabricated and integrated into the combat vehicle reaction mechanisms such as the main gun fire control. Adaptation of laser warning and missile launch detection will be initiated. Track and engine noise suppression and infrared signature suppression devices will be evaluated.

4. FY 1981 Planned Program: The evaluation of the prototype target acquisition fire control system will continue. The evaluation of fire detection and suppression system hardware performance data will continue. The Advanced Techniques for Electrical Power Systems (ATEPS) prototype hardware will be installed in an XM1 test bed and field tested. Track and suspension controlled damper testing will be completed. Evaluation of the Independent External Suspension System will commence and fabrication of vehicle track/wheel hardening initiated. Integration of a vehicle defense system will continue emphasizing the adaptation of warning receivers developed for aircraft use. Integration will proceed to initiate the warning and reaction mechanisms. Countermeasure of millimeter wave antitank guided missile threats will proceed through the incorporation of absorbing components resulting from joint Army, Navy, and Air Force research. Evaluation of military effectiveness of threat countermeasure devices will proceed.

5. Program to Completion: This is a continuing program.



FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.02.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Electric Power Sources

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
<b>TOTAL FOR PROGRAM ELEMENT</b>							
DC10	Electro-Chemical Power Source Development	2008	2445	2055	3336	Continuing	Not Applicable
DC11	Electro-Mechanical Power Source Development	626	2090	3000	2375	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: A continuing need exists to upgrade power sources for Army use. New and advanced state-of-the-art power generators, power conditioning devices, and power controls are required by the Army to meet general purpose, special purpose, or precision power applications that cannot be met with existing items. This program supports the development of advanced technology, components, and feasibility evaluations of tactical electric power sources and associated equipment. Current engine-driven generators, particularly in the 0.5 kilowatt (KW) to 10 KW power range, have low power efficiencies, are noisy, provide heat (infrared) signatures, require excessive maintenance and are not fuel economical. Present batteries and low-power sources for various communications and electronics hardware have short lives, are undependable, and are temperature sensitive. This program provides the necessary technologies required to develop improved mechanical- and chemical-type power sources with emphasis on equipment with greater mobility, higher efficiency, reduced fuel consumption, common components, noise and heat signature reduction, and multifuel and/or non-fossil fuel capability.

C. BASIS FOR FY 1980 RDT&E REQUEST: Pursue methanol fuel cell efforts of 3 KW and 5 KW capacities to satisfy requirements for a family of silent, lightweight tactical power sources. Investigate improved fuel cell system design, component materials, and logistics fuel processing. Continue efforts on ceramic components to increase the power output and fuel efficiency of gas turbine generators. Continue development of various power conditioning devices to provide required type and quality of power. Evaluate advanced concepts to reduce diesel generator fuel consumption and emissions. Conduct work on improved batteries and reliable, precision low-power generating sources.

Program Element: #6.37.02.A

Dod Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Electric Power Sources  
Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>	<u>Additional to Completion</u>	<u>Total Estimated Cost</u>
RDTE					
Funds (as shown in FY 1979 submission)	2709	4535	6000	Continuing	Not Applicable

In FY 1978 planned work on silencing existing generators was deferred as a result of lack of requirement documents. The FY 1980 budget difference indicates a slowdown in the effort to develop a hydrocarbon fuel cell.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.37.02.A

Dob Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Electric Power Sources  
Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The objectives of this program are to develop technologies and conduct feasibility demonstrations as prerequisites for engineering development (ED) of new and improved tactical military electric power sources. The projects encompass efforts on engine-driven power generation (electromechanical power), fuel cells and batteries (electrochemical power), and other power-related devices and technology to improve efficiency, type, and quality of power required to support Army tactical systems. Power requirements range from very low outputs (milliwatts) to moderately high outputs (hundreds of kilowatts). To satisfy low power demands, new type batteries are being developed which will provide high energy density, long storage life, operate over wide temperature ranges, and are smaller and lighter than present equivalent capacity batteries. Higher power needs will be met by the latest state-of-the-art engine-driven generators and fuel cells with emphasis on meeting Department of Defense goals for standardization of power generation equipment to achieve benefits of component commonality, reduced logistics support requirements, lower life-cycle costs, and improved fuel economy.

G. RELATED ACTIVITIES: The Army maintains continuing coordination with the other Services; Department of Energy; National Aeronautics and Space Administration; Department of Health, Education, and Welfare; and Department of Transportation through the Interagency Advanced Power Group, the Power Information Center, and the Department of Defense Project Manager for Mobile Electric Power. The Power Sources Conference sponsored by the US Army Electronics Research and Development Command provides a forum for exchange of information between government, academic, and industrial researchers. Additionally, the Joint Deputies for Laboratories (Panel for Batteries and Fuel Cells) assures coordination between the Services on programs concerning battery and fuel cell systems. Advanced Development items in this program element progress to engineering development in Program Element 6.47.14.A, Tactical Electric Power Sources. Related basic research is conducted in Program Element 6.11.02.A, Project AH47, Electronic Devices Research, and Project AH51, Combat Support. Exploratory development is conducted in Program Element 6.27.33.A, Mobility Equipment Technology.

H. WORK PERFORMED BY: In-house work is performed by the US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, and the US Army Electronics Research and Development Command, Fort Monmouth, NJ. Known and/or possible contractors include Englehard Industries, Menlo Park, NJ; Illinois Institute of Technology Research Institute, Chicago, IL; Energy Research Corporation, Bethel, CT; United Technology Corporation, Hartford, CT; Delco Electronics Division of General Motors, Goleta, CA; Solar Division of International Harvester, San Diego, CA; Mallory Battery Company, Terrytown, NY; and TRW, Incorporated, Redondo Beach, CA.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Major technology improvements of components of gas turbine engines have been made and, where applicable, have been incorporated in the engineering development (ED) design for the 10 kilowatt (KW), 60 Hertz (Hz) turbine generator. These improvements also are applicable to future turbine generator sets. Preliminary investigations of unique ceramic materials have demonstrated the potential of ceramic components to achieve significant improvement in performance and reduced fuel consumption of present state-of-the-art turbine generators. Tests of an initial prototype of a 15 KW general



Program Element: #6.37.02.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Electric Power Sources

Budget Activity: #2 - Advanced Technology Development

purpose power conditioner, which will provide regulated alternating current (AC) or direct current (DC) power from utility lines or engine generator sources, have confirmed the applicability of power conditioners to improve military power supply efficiency. Advanced development (AD) has been completed on the 1.5 KW fuel cell member of the Silent Lightweight Electrical Energy Plant (SLEEP) family, and a Validation In-Process Review (VAL IPR) has approved entry into engineering development (ED) for the 1.5 KW member of the SLEEP family. Lithium-type batteries demonstrated superiority over existing conventional batteries at temperatures to -40°F. Efforts were continued to improve designs of 100 watt and 500 watt thermoelectric generators as candidate low power multifuel silent power sources. Design of a 3.2 kilowatt (KW) AC to DC power processor feasibility model has been completed. The capability to upgrade the 10 KW Gas Turbine Engine-Driven (GTED) generator to 15 KW by using ceramic bearings, nozzle and combustor components was initiated and an evaluation was made of advanced silencing techniques for the 10 KW turbine generator set.

2. FY 1979 Program: Begin efforts to improve processing of logistics hydrocarbon fuels for fuel cells as a viable option to the use of methanol. Continue efforts to improve fuel cell components to improve reliability. Modify design of lithium-type batteries for safe and reliable operation for high energy requirements. Begin design of a feasibility model 2.5 KW AC to DC converter/regulator for use in military electronic digital equipment and electronic systems. Efforts to upgrade a 10 KW turbine generator to 15 KW output using ceramic components will be continued. Principles of exhaust regeneration will be examined to reduce turbine engine fuel consumption. Evaluations of improved noise reduction housings for varying capacity engine generators will be initiated. Efforts to improve diesel generator components to reduce fuel consumption and harmful emissions will be started. AD will be initiated on 3 KW and 5 KW fuel cell members of the silent power family. A demonstration test of a 1.5 KW hydrocarbon fuel cell will be conducted, and efforts to improve fuel processing and components for fuel cells will continue.

3. FY 1980 Planned Program: Safety, transportation, and disposal criteria for lithium organic batteries will be developed. Specifications for improved AD prototypes of 100 watt and 500 watt thermoelectric generators will be developed and fabrication of a test model will be initiated. A prototype 2.5 KW AC to DC converter/regulator will be designed and fabricated. Increase in funding for FY 1980 over FY 1979 is to accomplish key objectives for fuel cell silent power, improved generator efficiency and reduced fuel consumption efforts for turbines, and noise reduction for large capacity engine generators. Ceramic components will be used in a recuperator to improve fuel efficiency by heat recovery from turbine exhaust for the small engine sizes that power generators.

4. FY 1981 Planned Program: Efforts will be continued to: improve turbine engine - driven generators; develop improved fuel cell system component designs to meet silent lightweight power needs in the 3 and 5 KW sizes; develop simple hydrocarbon fuel processing technology for fuel cells; develop improved noise reduction and low emission means for existing high power engine generators; develop a 1.5 KW power conditioning device for general purpose applications; and develop precise uninterrupted and reliable low power sources, new batteries, thermoelectric generators, and control devices for communications and electronics systems. An inverter for the 5 KW fuel cell will also be developed.

5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.09.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Advanced Technology Demonstration of TMDE  
Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs	
							Not Applicable	Not Applicable
	TOTAL FOR PROGRAM ELEMENT	0	0	700	1900			
D633	Advanced Technology Demonstration of Test, Measurement, Diagnostic Equipment (TMDE)	0	0	500	1700	Continuing	Not Applicable	Not Applicable
D651	Calibration	0	0	200	200	Continuing	Not Applicable	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Present test equipment and techniques will make required field readiness virtually impossible to achieve on new and follow-on Army weapons systems. The numerous variety of test equipment and application techniques require a highly trained and unusually skilled technician to spend considerable amounts of time manually diagnosing and repairing vital mission equipment. These procedures delay equipment turnaround time and increase shelf time of equipment awaiting repair. The development of advanced test equipment and associated techniques will make field readiness achievable by reducing the variety of test equipment now present in the system, providing test sets with much greater technical capability and application, and reducing the technical skill and time required by the Army technicians. Efforts will be directed toward the development of versatile modular test sets applicable to a greater number of mission essential weapons systems. The objective of the calibration program is to develop new or improved measurement standards equipment required to support Army calibration services throughout all phases of the life cycle of materiel. Advancement in metrology must be made not only by increasing the precision and accuracy of existing standards, but also by developing new types of standards and processes for new Army technology under development.

C. BASIS FOR FY 1980 RDTE REQUEST: Expand the utilization and versatility of modular forward area test sets by developing those additional plug-in modules required as peculiar Test, Measurement, Diagnostic Equipment (TMDE) in the integrated logistics support plans of weapon system developers. This will eliminate the need to develop completely new special purpose test equipment to support these systems. Obsolescence will be avoided by the design and development of advanced modules with higher scan frequencies, increased speed and power capabilities, and the development of software tools to reduce cost and to improve the exchange of test programs among Automatic Test Equipment (ATE) systems. The calibration effort will include development of measurement standards equipment and techniques for high energy lasers, optical guided wave systems and millimeter wave systems.

Program Element: #6.37.09.A  
 BD Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Advanced Technology Demonstration of TMDE  
 Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
	0	600	1200	Continuing	Not Applicable

Program funds to support both projects were deleted by Congress for FY 1979 causing a deferral of program plans until FY 1980. Projects D633 and D651 were submitted in FY 1979 under PE 6.37.48.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.37.09.A

DoD Mission Area: #246 - Mobility and Logistics

Technology Demonstration

Title: Advanced Technology Demonstration of THIE  
Budget Activity: #2 - Advanced Technology Development

**F. DETAILED BACKGROUND AND DESCRIPTION:** Provides the advanced development models of test equipment by which a more effective means of diagnosis of future Army weapon systems can be made. Development will continue on expanding the utility of versatile modular test sets to make them applicable to a greater number of weapon systems. Engineering analysis will be conducted on Army end item systems presently under development to identify the test requirements that will be required for their field support. Designs will be developed for the required stimuli for measuring and switching Automatic Test Equipment (ATE) models; for distributed processing control, and simplified operator interfaces. The overall objective of the calibration program is to develop new or improved measurement standards equipment needed by the Army to support and validate the new measurement requirements introduced during research, development, production, operation, and maintenance. In an effort to stay abreast with the measurement demands of the Army systems and weapons under development, measurement science must be continuously advanced in support of critical technological equipment.

**G. RELATED ACTIVITIES:** Program Elements (PE's) 6.27.79.A (Test, Measurement and Diagnostics Technology), 6.37.48.A (Automatic Test Equipment), and 6.47.46.A (Automatic Test Support Systems), accomplish the exploratory development, engineering development, and advanced development, respectively, for work covered under this program.

**H. WORK PERFORMED BY:** In-house work is performed by US Army Communications Research and Development Command, Ft Monmouth, NJ, and the US Army Missile Readiness Command, Redstone Arsenal, AL. Contractors include SPAR Optical Research Inc., Corona, CA; Electron Dynamic Division, Hughes Aircraft Company, Torrance, CA. There are no contracts in effect for FY 19/8 and FY 1979 for project D633.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. **FY 1978 and Prior Accomplishments:** Project D633 was initiated in FY 1978, but funding was deleted at the beginning of the fiscal year. Related work was continued under PE 6.27.79.A.
2. **FY 1979 Program:** Funds for projects D633 and D651 were deleted by Congress. No new efforts were undertaken, except to prepare for the FY 1980 planned program. Related efforts continued under PE 6.27.79.A.
3. **FY 1980 Planned Program:** Efforts under this program element for both projects will begin. Under D633, development of additional plug-in measurement and stimuli modules to meet new integrated logistics support requirements of Army weapon systems at direct and organizational support (DS/ORG) levels will be initiated. Development of software tools to facilitate validation and configuration control of test program sets (TPS) for this modular test equipment will begin. Development of methods on how to make test software, written for a particular ATE, work with the Army's different automatic test systems will begin. Under project D651 efforts will resume in the development of high energy laser standards. A contract will be awarded to fabricate an actual device and test its performance against National Bureau of Standards (NBS) calorimeters. Participate

Program Element: #6.37.09.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstration

Title: Advanced Technology Demonstration of THMR  
Budget Activity: #2 - Advanced Technology Development

In Joint Logistics Commanders (JLC) Panel on matters relating to advanced technology of Test, Measurement, Diagnostics Equipment (TMDE). Also, the development of a millimeter wave standard will be initiated. This development is needed for calibration support of surveillance and homing devices being developed that operate at 95 GHz. To establish the extent of the measurement problem existing in the Army optical communications systems, specific calibration setups for optical measurements will be made in a laboratory environment.

4. FY 1981 Planned Program: Project D633 will continue new development of stimuli and measurement modules to expand the capability of automated systems to satisfy the needs of weapon system developers. Developmental work will be initiated on a data bus analyzer to perform system evaluation/fault isolation of computer embedded systems. Initiate an evaluation of hardware/software to determine the effectiveness of multi-station distributed processing techniques for Automatic Test Equipment (ATE) applications. Project D651 principal effort will be directed toward the development of millimeter wave power density standards at 140 GHz and 222 GHz. Army measurement and calibration systems at these frequencies will be fabricated and suitable standards hardware designed and built. High energy laser standards testing phase and final reports will be completed and prototype working standards turned over to White Sands Missile Range and Redstone Arsenal. Equipment and standards procured in FY 1980 will be assembled and tested as an operating calibration system to support calibration of fiber optic components.

5. Program to Completion: This is a continuing program.

FY 1980 RITE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: 86.37.10.A

Dod Mission Area: 2213 - Search and Reconnaissance, Surveillance, and Target Acquisition

Title: Night Vision Advanced Development  
Budget Activity: 02 - Advanced Technology Development

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs	Not Applicable
	<b>TOTAL FOR PROGRAM ELEMENT</b>	<b>11231</b>	<b>8437</b>	<b>14017</b>	<b>22472</b>			
DK70	Night Vision Advanced Development	11231	8437	8701	14472	Continuing	Not Applicable	
DK86	Night Vision Airborne Sys	0	0	2287	3000	Continuing	Not Applicable	
DK87	Night Vision Combat Vehicles	0	0	3029	5000	Continuing	Not Applicable	

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** The Army must have an improved capability to fight at night in order to successfully engage in future 24-hour a day conflicts, employing all the air and ground weapons used in daylight at night and during limited visibility. Massive firepower and pinpoint weapon accuracy are useless unless targets can be acquired and located. The objective of this program is to apply recent advances in technology to reduce the life cycle costs of night sights and techniques to provide the Army with the necessary improved night and limited visibility fighting capability. With this capability, the Army will be able to counter a foe that plans and trains to continue combat operations during periods of darkness and obscured visibility. The night vision devices developed are used by the individual soldier (rifle and crew served weapon sights, goggles), antitank missile systems (TOW and DRAGON night sights), helicopters, and combat vehicle applications (Tank Thermal Sight). The Army has a requirement to field over 100,000 systems providing a night vision capability for the individual soldier and crew served weapons. The current devices use technology which prohibits meeting this requirement economically. The continued development and fielding of low cost night vision aids using the advanced 3d generation image intensifier tube will resolve this dilemma. The recent accomplishments in Soviet thermal system capability impose a demand on the United States to continue its lead in this area. While the current common module infrared (MOD FLIR) systems can and do provide extremely high performance for surveillance, target acquisition, and fire control, the technology places a severe limitation on the size and weight below which manportable thermal sights may not be reduced. Fielding over 20,000 systems with less size, weight, and cost than the current devices will allow the Army to meet and counter the threat. To reduce the time of target acquisition, identification and engagement, while increasing survivability and the accuracy of fire control for both aircraft and combat vehicles, will require development and integration of new technology. A critical portion of this technology is the implementation of counter-countermeasures to all methods whereby the fire control systems can be rendered ineffective. This program bridges the gap between the efforts of Night Vision Investigations (6.27.09) and Night Vision Devices (6.47.10).

**C. BASIS FOR FY 1980 RITE REQUEST:** Image intensifier efforts will be to overcome the cost problem of night vision goggles by development and testing of low cost night vision aids. Developments within thermal technology will concentrate on a prototype of second generation manportable thermal imaging systems with less than one-half the size, weight, and cost of present systems.



Program Element: #6.37.10.A

DoD Mission Area: #213 - Search and Reconnaissance,  
Surveillance, and Target Acquisition

Title: Night Vision Advanced Development  
Budget Activity: #2 - Advanced Technology Development

Integration of technologies for automatic cueing and tracking of targets, as well as improved detector sensitivities, will increase the stand-off range and performance of aircraft and combat vehicle systems. Application of experimental data will permit development of counter-countermeasures techniques and devices to negate the effects of obscurants (smoke, fog, haze, and dust).

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>	<u>Additional to Completion</u>	<u>Total Estimated Cost</u>	<u>Not Applicable</u>
RDTE Funds (as shown in FY 1979 submission)	11031	13137	18300	Continuing		

The increase in FY 1978 (\$200) was due to Army reprogramming to support the FLIR augmented Cobra TOW sight (FACTS). Decrease in FY 1979 was due to Army reprogramming for the Advanced Attack Helicopter. Reduction in FY 1980 are due to internal Army reprogramming for remotely piloted vehicles (RPV) and Stand Off Target Acquisition System (SOTAS) and budget constraints.

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.37.10.A

DoD Mission Area: #213 - Search and Reconnaissance,  
Surveillance, and Target Acquisition

Title: Night Vision Advanced Development  
Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: 3d generation image intensification tubes will be developed in configuration for a high performance pilot's night vision goggle, and for a low cost night vision aid. The current 2d generation tubes allow Nap-of-the-Earth (NOE) flight at one quarter moonlight or brighter conditions and cost about \$2200 per tube. The 3d generation tubes will, in their high performance configuration, cost approximately the same, but will allow for NOE flight with only starlight. In the low cost configuration the tubes will perform as well as the 2d generation tube but with an estimated unit cost of \$600. The performance of image intensification night sights which currently provide the night vision capability for individual and crew served weapons is seriously degraded in limited visibility (fog or smoke) this degradation can be overcome by infrared technology. The infrared area will continue the development of a family of modules utilizing 2d generation 8-12 micron technology for lightweight manportable systems. The Army is currently procuring systems which use current generation 8-12 micron parallel scan (common module) technology. The use of common modules results in a substantial procurement savings with eventual life-cycle cost reduction. Common modules represent a quantum improvement over previously developed devices; their shortcomings of size and weight will be addressed by the 2d generation technology. From this new technology will evolve a class of modules which will satisfy stringent requirements for the lightweight manportable thermal weapon sight. A lightweight infrared sight will be developed with performance which has only limited degradation in smoke and fog, and is cost competitive with the existing devices. These sights will not require bottles of compressed air for cooling, will be one-half the weight of the 1st generation systems, and will be able to satisfy extended range requirements. In the combat vehicle area the basic Tank Thermal Sight, which makes use of the 1st Generation Thermal Imaging Common Modules, will have the "time to kill" reduced by a factor of two or more by the use of signal processing and automatic tracking. A prototype model of a low cost far infrared driving periscope will be procured and evaluated. Use of far infrared technology for driving will increase ability of vehicles to navigate under conditions of low visibility (fog, smoke, etc.). Feasibility prototypes of the Advanced Heavy Antitank Missile System (AHAMS) Night Sight will be developed and their application to an Advanced Medium Antitank Weapon System (AMAWS) investigated. To overcome the performance degradation of the passive thermal tank night sights in heavy smoke and fog, the Surveillance Target Acquisition Radar Tank Location and Engagement (STARTLE) System, using active millimeter wave radar linked with passive infrared sight, will be developed. The passive sight will be used the majority of the time; the active radar will be used only when the thermal sight performance is degraded by obscurants (heavy fog, dust, and smoke).

G. RELATED ACTIVITIES: The Army's Night Vision Laboratory has been assigned the responsibility for coordination of all night vision technology based programs within the three Services to avoid duplication and to ensure that maximum use is made of resources and capabilities within the Department of Defense (DOD) community. Additionally, active international technical interchange is maintained with National Atlantic Treaty Organization (NATO) through Panel VI (Combat Intelligence) of the NATO Army Armaments Group (NAAG). The Federal Republic of Germany Memorandum of Understanding (MOU) for the sale and coproduction of the DOD Standardized Common Modules is being executed. Germany's plan to use Common Modules on their LEOPARD I & II, MARDER, and LUCHS vehicles is a significant step forward in NATO standardization for Thermal Imaging Systems. Negotiations are in progress on an MOU for sale and coproduction of common modules with Italy, the United Kingdom, and the Netherlands within NATO.

Program Element: #6.37.10.A

DoD Mission Area: 213 - Search and Reconnaissance,  
Surveillance, and Target Acquisition

Title: Night Vision Advanced Development  
Budget Activity: 2 - Advanced Technology Development

**H. WORK PERFORMED BY:** Work is performed by the US Army Night Vision and Electro-Optics Laboratory, Fort Belvoir, VA, with contractor assistance. Representative contractors include: International Telephone and Telegraph Corporation, Fort Wayne, IN; Varian Associates, Palo Alto, CA; Texas Instruments, Inc., Dallas, TX; Aeronutronics Ford Corporation, Newport Beach, CA; and Hughes Aircraft, Culver City, CA.

**I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

1. **FY 1978 and Prior Accomplishments:** Third Generation Image Intensification Tubes with high sensitivity have been fabricated and given limited field testing; Low Cost Goggle Tube designs have been hardened. The performance qualification of 1st generation Infrared Common Module competitive sources has been completed. The fabrication of 2d generation infrared common modules has been initiated. A Neodymium laser rejection filter for image intensifiers was demonstrated. The closed cycle cooler for manportable, Night Observation Device Long Range (NODLR) was developed. Remotely Piloted Vehicles (RPV) sensors were procured.
2. **FY 1979 Program:** Fabrication and testing of tubes for low cost night vision aids. Award contract for low cost night vision aids (goggles) using the low cost tubes. Complete improvements of 1st Generation Infrared Common Modules that will result in increased maintainability and durability, through use of solid circuitry. The pyroelectric vidicon developed for perimeter security will transition to Full Scale Development. Procure and evaluate thermal imaging for combat driving. Qualify the battery powered split cycle cooler for the Night Observation Device, Long Range (NODLR). Approval of Letter of Agreement on the Low Cost Night Vision Aids. Flight test of 3d Generation Pilots Night Vision Goggles.
3. **FY 1980 Planned Program:** The Advanced Development design will be completed for both high sensitivity and low cost 3d generation tubes which will transition to full scale development. In addition, the Force Development Test and In-Process Review of the Low Cost Night Vision Aids using these tubes will be completed. Using advanced technologies for the 2d Generation 3-5 micron systems, a family of high performance thermal imaging modules will be developed. A program on the infrared jammer sources will be initiated. Contracts will be awarded for a far infrared driving periscope if FY 1979 efforts are successful. Prototypes will be demonstrated of Night Sight for Advanced Heavy Antitank Missile System. Airborne flight test will be conducted of COBRA helicopter with thermal imaging common modules to provide night and limited visibility capability with TOW antitank missiles mounted on the aircraft. Development and Operational Test I will be conducted followed by an In-Process Review for the infrared rifle sight and one tube holographic goggles.
4. **FY 1981 Planned Program:** Complete advanced development of pyroelectric vidicon for drivers periscope. Evaluate prototype of advanced combat vehicle night sight. Validation of counter-measures for night sights. Evaluate feasibility model of Advanced Heavy Antitank Missile System Night Sight Equipment. Transition to Engineering Development for infrared individual weapon sight. Evaluate 2d generation thermal sight for helicopter operations. Evaluate demonstration model of STARTLE (Surveillance Target Acquisition Radar for Tank Location and Engagement).



Program Element: #6.37.10.A  
DoD Mission Area: #213 - Search and Reconnaissance,  
Surveillance, and Target Acquisition

Title: Night Vision Advanced Development  
Budget Activity: #2 - Advanced Technology Development

5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #DK70

Program Element: #6.37.10.A

DoD Mission Area: #213 - Search and Reconnaissance,  
Surveillance, and Target Acquisition

Title: Night Vision Advanced Development

Title: Night Vision Advanced Development

Budget Activity: #2 - Advanced Technology Development

A. DETAILED BACKGROUND AND DESCRIPTION: The Army has the need for a cost-effective ability to fight during periods of darkness and limited visibility with a relative combat capability that equals that during daylight. This project applies new techniques, components, and devices to produce significant cost reductions and performance improvements for night vision devices to meet that need. The combat capability is required to counter the threat of a foe that plans to continue combat operations during periods of darkness and limited visibility. The objective of this project is the advanced development of night vision components and devices which have applications independent of specific weapons systems or vehicles. This is the base project for the program element and includes both infrared and image intensification technologies.

B. RELATED ACTIVITIES: Related projects are 6.37.10/DK86 (Night Vision Airborne Systems), and 6.37.10/DK87 (Night Vision Combat Vehicles). These latter projects have been established to increase management visibility. The Army's Night Vision and Electro-Optics Laboratory has been assigned the responsibility to coordinate all night vision technology based programs within the three Services to ensure maximum use is made of resources and capabilities within the Department of Defense (DOD). Active international technical interchange is maintained within National Atlantic Treaty Organization (NATO) Army Armaments Group (NAAG). Configuration control is maintained for common modules produced for United States systems as well as those produced under the Memorandum of Understanding with the Federal Republic of Germany.

C. WORK PERFORMED BY: Work is performed by the US Army Night Vision and Electro-Optics, Ft Belvoir, VA; with contractor assistance. Representative contractors include: International Telephone and Telegraph Corporation, Fort Wayne, IN; Varian Associates, Palo Alto, CA; Texas Instruments, Dallas, TX; and Hughes Aircraft, Culver City, CA.

D. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Second Generation Image Intensifier tubes and devices have been developed, tested, and are in production. First Generation Infrared Common Modules have been standardized within the three Services and are in production for such items as the AN/TAS-4, TOW Night Sight; and AN/VSC-2, Tank Thermal Sight. High sensitivity Image Intensification Tubes have been fabricated and given limited field testing. Low Cost Night Vision Aid Tubes have been fabricated. The performance qualification of 1st generation infrared common module competitive sources has been completed. The fabrication of 2d generation infrared common modules has been initiated. A neodymium base rejection filter for image intensifiers was demonstrated. A battery powered closed cycle for manportable thermal sights was developed to replace the current compressed gas powered cooler.

Project: DDK70

Program Element: #6.37.10.A

DoD Mission Area: #213 - Search and Reconnaissance, Surveillance, and Target Acquisition

Title: Night Vision Advanced Development

Title: Night Vision Advanced Development

Budget Activity: #2 - Advanced Technology Development

2. FY 1979 Program: Pilot's Night Vision Goggles using 3d generation image intensifier tubes will be flight tested. Fabricate and test tubes for Low Cost Night Vision Aids. Following approval of a Letter of Agreement, award contract for these low cost devices. Complete improvement to 1st generation Infrared Common Modules to reduce life cycle costs by increased durability through the use of solid circuitry. Complete advanced development of pyroelectric vidicon for perimeter security. Harden and qualify the split cycle cooler for the Night Observation Device, Long Range, for fielding. Evaluate thermal imaging viewers for combat vehicle drivers.

3. FY 1980 Planned Program: The Advanced Development design for both high sensitivity and low cost 3d generation image intensifier tubes will be completed. Transition to Full Scale Development of the Low Cost Night Vision Aids will be started following completion of testing and In-Process Review (IPR). Using advanced technologies in the 3-5 micron range, a family of high performance thermal imaging modules will be developed and tested in Developmental and Operational Test I. A program on infrared jammers will be started. Prototypes of a night sight for the Advanced Heavy Antitank Missile System will be demonstrated.

4. FY 1981 Planned Program: Develop and validate counter-countermeasures for night sights. Transition the 3-5 micron thermal imaging individual weapon sight to engineering development. Evaluate the feasibility model of the Advanced Heavy Antitank Missile System night sight.

5. Program to Completion: This is a continuing program.

6. Major Milestones: Not applicable.

7. Resources (\$ in thousands):

	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total Estimated Cost	Not Applicable Not Applicable
RDTE							
Funds (current requirements)	11231	8437	8701	14472	Continuing		
Funds (as shown in FY 1979 submission)	11031	8437	18300	--	Continuing		

Reductions in FY 1980 (\$9596) are due to separation of projects DKK86 and DKK87 (\$5316) and budget constraints.



FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.25.A  
 DoD Mission Area: #214 - Target Exploitation  
 Title: Remotely Piloted Vehicles (RPVs)/Drones  
 Budget Activity: #2 - Advanced Tech Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs	
							Not Applicable	
TOTAL FOR PROGRAM ELEMENT QUANTITIES								
DK61	Remotely Piloted Vehicles/ Drones	8160	2191	3496	3413	Continuing	Not Applicable	

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides an Advanced Development base for Improvements to the Target Acquisition Designation Aerial Reconnaissance (TADAR) RPV being developed under Program Element (PE) 6.47.30.A and for the development of additional RPV mission capabilities other than TADAR. RPVs are required to extend the eyes of the Brigade and Division commanders to the range of their artillery, increase the effectiveness of their direct support firepower, and provide laser designation for laser guided weapons. Projected Improvements to the TADAR system include night/adverse weather sensors utilizing Forward Looking Infra-Red (FLIR) and Millimeter Radar technology; improved command and control techniques such as multiple air vehicle control from a common ground station and extended range data links; survivability enhancement testing, studies and simulations; laser rangefinder/designator troop safety improvements; air vehicle propulsion development; and improved flight control systems. Additional mission capabilities include communications and non-communications jammers, weather sensors, communications relay platforms, radiac survey and decoy.

C. BASIS FOR FY 1980 RDT&E REQUEST: RPV sensor developments will continue with heavy emphasis on developing a night/adverse weather sensor capability for mini-RPV applications. The survivability enhancement program will continue with emphasis on Infrared (IR) vulnerability testing and simulations. The United Kingdom (UK) Remotely Piloted Helicopter effort will continue to be investigated in an effort to take advantage of mutual requirements in propulsion, command and control, sensor and survivability techniques through the US/UK Memorandum of Understanding. Eye Safe Laser technology is expected to transition from PE 6.37.25.A for development into the TADAR laser program permitting realistic training without compromising troop safety. Continued flight testing of equipment resulting from RPV supporting technology programs will be conducted in manned aircraft and with residual RPV hardware assists in order to reduce technological and schedule risks in on-going RPV programs.

Program Element: #6.37.25.A  
DoD Mission Area: #214 - Target Exploitation

Title: Remotely Piloted Vehicles (RPVs)/Drones  
Budget Activity: #2 - Advanced Tech Development

F. DETAILED BACKGROUND AND DESCRIPTION: The objective of the Army RPV program is to field a series of lightweight, small sized RPVs that operate in a tactical environment to accomplish a broad range of mission capabilities. Initial efforts are oriented on the early fielding of an RPV with daylight television and laser designator/range-finder to meet the need for target acquisition, adjustment of artillery fire, laser target designation and reconnaissance beyond the forward edge of the battle area (FEBA) and past the range of ground observers. Follow on efforts are oriented at providing this system with improved night/adverse weather sensors and improved command and control capabilities that permit multiple air vehicle operations from a single ground control station as well as operations at greater ranges. In a parallel effort the development of other mission capabilities for mini-RPVs are being pursued to provide a broad range of capabilities for use beyond the FEBA. Commonality of components within the Army programs and with other service programs is being pursued. The major activities to date have been the Aquila System Technology Demonstrator Program which completed testing in FY78 and its associated supporting technology programs.

G. RELATED ACTIVITIES: Within the Army, Exploratory Development of RPV technology is conducted under Program Element (PE) 6.27.32.A, RPV Supporting Technology. Full scale engineering development (ESRD) or Engineering Development of the first Generation RPV will be conducted under PE 6.47.30.A, Remotely Piloted Vehicles. This program element (6.37.25.A) provides an Advanced Development base for transitioning Supporting Technology programs into Engineering Development. Air Force RPV programs consisting of PE 6.37.39.F, Advanced RPVs, and PE 6.47.46.F, Expendable Drones, are being monitored to preclude duplication of effort and commonality of design where possible. Quarterly Joint Technical Coordinating Group (JTCC) meetings are held between the Army and Air Force RPV program managers to further this initiative. Interoperability is being pursued through a Memorandum of Understanding with the United Kingdom (UK). At the current time, there is no duplication of effort in mini-RPVs within the Services.

H. WORK PERFORMED BY: US Army Aviation Research and Development Command, St. Louis, MO; Combat Surveillance Target Acquisition Laboratory, US Army Electronics Research and Development Command, Fort Monmouth, NJ; Night Vision and Electro Optics Laboratory, US Army Electronic Research and Development Command, Fort Monmouth, NJ; Research and Technology Laboratories, Aero Mechanics Lab, Moffett Field, CA; Applied Technology Lab, Fort Eustis, VA; and the US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA. Contractors actively participating in the RPV development are Lockheed Missiles and Space Company, Inc., Sunnyvale, CA; Aeronutronic Ford, Newport Beach, CA; Teledyne Ryan, San Diego, CA; Texas Instruments, Dallas, TX; Honeywell, Minneapolis, MN; Harris Corporation, Melbourne, FL; Norden, Norwalk, CT; Teledyne Continental Motors, Mobile, AL; Aerotech Industries, Auburn, AL; and Development Sciences, Inc., Industry, CA.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: In FY 1973 and FY 1974, the Remotely Piloted Aerial Observer/Designator System (RPAODS) program yielded parametric data in such areas as detectability, survivability, target search and acquisition, target tracking. In FY76, a demonstration was conducted using the Aeronutronic Ford (formerly Philco Ford) PRAETIRE II RPV to laser

Program Element: #6.37.25.A  
DoD Mission Area: #214 - Target Exploitation

Title: Remotely Piloted Vehicles (RPVs)/Drones  
Budget Activity: #2 - Advanced Tech Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>	<u>Additional to Completion</u>	<u>Total Estimated Cost</u>
					<u>Not Applicable</u>
	9211	2219	3230	Continuing	

Reduction in FY78 is due to funds being reprogrammed to satisfy immediate requirement for the mast mounted sight program under Program Element (PE) 6.32.06. FY80 estimate was increased to place emphasis on night/adverse weather sensor capability.

E. OTHER APPROPRIATION FUNDS: Not Applicable.



Program Element: #6.37.25.A

DoD Mission Area: #214 - Target Exploitation

Title: Remotely Piloted Vehicles (RPVs)/Drones

Budget Activity: #2 - Advanced Tech Development

designate a tank target for a laser seeking Cannon Launched Guided Projectile (CLGP). A direct hit was scored. During this same time period an initial effort was made to integrate a small, lightweight jammer in a mini-RPV. Based on general requirements derived from the Remotely Piloted Aerial Observer/Designator System (RPAODS) program, the Aquila System Technology Demonstration Program was established in FY75. Contractor flight testing of Aquila was initiated in mid FY 1976. In April 1976, after a series of unsuccessful tests, the program was stopped and thoroughly reviewed by the contractor and an Army Review Team. Problems were traced to faulty procedures and designs and some instances of inadequate reliability and testing. Over 30 engineering changes resulted from the review and after extended ground testing the program continued successfully. Aquila has in excess of 195 flights to date and has successfully demonstrated automatic launch, flight and navigation; semi-automatic recovery in an unimproved area; target detection, recognition and laser range-finding/designation, artillery adjustment and handoff of control from one Ground Control Station to another. A second RPV laser designation for the COPPERHEAD precision guided munition was successfully performed in FY78. Formal user testing was conducted in simulated field conditions in order to determine the RPVs place in the force structure and how it should be integrated into the command, control and target acquisition system. User and developer testing was concluded in FY78. Information acquired from this program has been used in the development of the system Required Operational Capability. This program was approved to enter Full Scale Engineering Development (FSED) by Headquarters Department of the Army (HQDA) in late FY78 and has been transitioned to Program Element (PE) 6.47.30.A, Remotely Piloted Vehicles. While the objectives of the program were met many problem areas were identified that required parallel development effort. These programs focused on improvements in propulsion, launch and recovery techniques, servo-actuators, and manufacturing and design techniques. An anti-jam data link program was initiated in FY76 to provide an improved command and control capability. The resulting hardware consisted of two airborne data terminals integrated in Aquila RPVs and one ground station. Flight testing was successfully concluded in FY78. The resulting system provided the baseline for the data link that is to be used on the FSED RPV under PE 6.47.30.A. Survivability/vulnerability studies, testing and simulations were conducted in FY78. These included live firing ballistic weapon tests as well as Infrared (IR) and radar tracking tests and simulations. Work is continuing in this area. Additional efforts included night sensor Forward Looking Infra-Red, (FLIR) tests on manned aircraft; flight testing of tunable and barrage jammers; parachute recovery tests and engine and propeller test and evaluation.

2. FY 1979 Program: Development of night sensors (which will also be effective in reduced daylight conditions such as haze and smoke) will be the major thrust. Basic initiative is aimed at selected component level improvements and developments leading to an Advanced Development night mission payload program beginning in FY80. Component development includes the design and fabrication of an electronic multiplexer that makes the common-module FLIR output compatible with the bandwidth compression module input to the RPV data link; basic common-module FLIR autotracker designs; common optics design for FLIR and laser range-finder; and an effective laser range-finder active boresight technique. Component improvements include upgrading of sensitivity and resolution performance and flight test of two serial scan (mini) FLIRs developed under PE 6.27.32.A in FY78. The testing/demonstration program includes completion of Ground Control Handoff demonstration that began in FY 1978; refinement of burst offset tracking techniques for artillery adjustment, demonstration of night recovery; testing of spectral filters for television sensor to allow easier detection of artillery shell burst; and flight testing of improved autotrackers. Survivability initiatives include IR tracking susceptibility tests using an instrumented STINGER seeker head and air-to-air detection tests. A survivability simulation

Program Element: #6.37.25.A

DoD Mission Area: #214 - Target Exploitation

Title: Remotely Piloted Vehicles (RPVs)/Drones

Budget Activity: #2 - Advanced Tech Development

facility program will be initiated to provide a capability to assess the survivability of the RPV on the battlefield for changing RPV configurations, tactics and threats throughout the life of the RPV system. The United Kingdom (UK) vertical take-off and landing RPV program will be monitored under the purview of the US/UK Memorandum of Understanding (MOU) on RPV interoperability. Electronic warfare (EW) jammers will be tested in manned aircraft and RPVs in conjunction with the Signal Warfare Laboratory.

3. FY 1980 Planned Program: Forward Looking Infra-Red (FLIR) component development/improvements initiated in FY79 will be completed along with improved serial scan (mini) FLIR flight tests. In-house effort will be initiated for Request for Quotation (RFQ) preparation and Source Selection of contractor for Advanced Development (AD) night/limited adverse weather mission payload package for RPVs. The mission payload package will include FLIR sensor, laser rangefinder/designator, autotracker and associated electronics and packaging. Contract award for this 27 month program is planned for mid FY80. Survivability simulation development continues as well as possible continuation of testing using improved CHAPARRAL and HAWK Systems. The Eye Safe Laser program transitions from Program Element (PE) 6.27.32.A, RPV Supporting Technology. Initiative is to prove Eye Safe Laser technology and hardware in manned aircraft sensor platforms and RPVs. Initiatives with UK on VTOL and interoperability continue.

4. FY 1981 Planned Program: FLIR AD development program continues from FY80. Engineering and design effort is completed. Fabrication on deliverable hardware begins. Multi-control program transitions from PE 6.27.32.A. This program is a multi-year effort that involves fabrication of an improved ground control station for control of multiple air vehicles. Initiatives with UK on VTOL and interoperability continue. Development of the survivability modeling capability will be completed.

5. Program to Completion: This is a continuing program.

FY 1980 RDT&E CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.31.A

DoD Mission Area: #222 Training and Personnel Technology

Title: Manpower and Personnel

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Continuing	Total Estimated Costs	Not Applicable
A/92	TOTAL FOR PROGRAM ELEMENT Manpower and Personnel	3775	1823	3121	3868	Continuing	3868	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:

1. User Problem: The active Army and Reserve Components need to recruit and retain the quantity and quality of skilled, capable people to meet present-day and future requirements. The Army must compete in the open market for recruits where recruiting mistakes are costly, can cause unnecessary attrition, and unnecessary personnel turbulence, and leave Army units in the field undermanned. The Army lacks the ability to measure soldier attitudes, aspirations, and other factors that contribute to soldier success.

2. Objectives: Research must be conducted to (a) identify ways to broaden the population base for Army recruiting; (b) determine factors which appeal to new enlistees and soldiers; (c) improve indicators of soldier success; (d) reduce attrition of trained manpower; (e) enhance non-material reward for Army service; (f) insure that manpower and personnel factors are considered in determining the Army's capability to completely afford a new Army organizational structure or materiel system.

3. Products: (a) An analysis of factors and incentives affecting enlisted soldiers' motivation to complete term of service and to reenlist; (b) selection criteria for artillery forward observer teams; (c) tests for measuring soldier success; (d) Military Applicant Profile (MAP) for screening marginal enlistees; (e) new Armed Services Vocational Aptitude Battery to improve prediction of aptitude for military occupational specialties; (f) input to policy guidance on how to increase realistic attractiveness of the Army to wider segments of the population; (g) basis for incentives and non-material rewards.

4. How Used: Army standards for recruitment, classification, training and assignment of personnel are based upon this research. The work is used in assessing soldier performance, measuring soldier skill levels, establishing personnel mental standards, determining criteria for recruitment appeals and practices, controlling personnel attrition, guiding utilization of military personnel, and setting retention and promotion standards. This work guides the Office of the Assistant Secretary of the Army for Manpower and Reserve Affairs and the Office of the Deputy Chief of Staff for Personnel (ODCSPER) policy formulation regarding these issues. This research also assists the ODCSPER in determining manpower and personnel costs associated with the total affordability of new Army organizations and new weapons systems.



Program Element: #6.37.31.A

DoD Mission Area: #222 Training and Personnel Technology

Title: Manpower and Personnel

Budget Activity: #2 - Advanced Technology Development

C. BASIS FOR FY 1980 RDTE REQUEST: Develop guidelines to retain and reenlist successful first-term soldiers. These will apply to both Active Army and Reserve Components. Develop procedures to integrate manpower and personnel costs into total affordability associated with activation of new organizations and deployment of new weapon systems. Develop procedures for better personnel management to reduce personnel turbulence. Methodology for selection of recruiters will be improved. Guidelines for officers to better understand and utilize available manpower and materiel resources will be developed. A realistic personnel feedback system will be developed which includes soldier trainability, attitude, aspirations, and performance. Research will be initiated to determine appropriate criteria for and effectiveness of non-material reward for success.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL BUDGET REQUESTS: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional To Completion	Total Estimated Cost
RDTE					
Funds (as shown in FY 1979 submission)	4024	4786	6431	Continuing	Not Applicable

Changes in this program element are primarily a result of restructuring in response to Congressional guidance.

E. OTHER APPROPRIATE FUNDS: Not Applicable

Program Element: #6.37.31.A

DoD Mission Area: #222 Training and Personnel Technology

Title: Manpower and Personnel

Budget Activity: #2 - Advanced Technology Development

**F. DETAILED BACKGROUND AND DESCRIPTION:** Previous research has identified military problems related to attrition and screening of potential performance failures. This program will determine what motivates young people to join the Army Reserve and National Guard and what is responsible for their high attrition. Research on retention and reenlistment for both Active and Reserve Component forces will relate characteristics of successful reenlistees to Army reenlistment policies. Other research concentrates on methods to improve officer precommissioning and on management for improving combat readiness. Unusual emphasis has been placed on integrating manpower and personnel issues associated with "total weapon system affordability."

**G. RELATED ACTIVITIES:** Through the Department of Defense, this work is coordinated with Naval Personnel Support Technology, 6.27.63N; Navy Manpower Control System Development, 6.37.07N; Air Force Personnel Utilization Technology, 6.27.03F. Related Army Program Element is Manpower, Personnel and Training, 6.27.22A. Inter-service coordination is effected through annual tri-service Department of Defense Technology Coordinating Papers, and tri-service committees in such areas as education and training, manpower, women, and organizational effectiveness.

**H. WORK PERFORMED BY:** Contractors include: General Research, McLean, VA; Personnel Decision Research Institute; Minneapolis, MN; Galler Associates, Arlington, VA; McBer and Co., Boston, MA; Human Sciences Research, Inc., McLean, VA. More than two-thirds of the funds expended for contracts are for competitive procurements. In-house research is performed by the US Army Research Institute for the Behavioral and Social Sciences, Alexandria, VA, and its field units at Presidio of Monterey, CA; Ft Benning, GA; Ft Bliss, TX; Ft Hood, TX; Ft Knox, KY; Ft Leavenworth, KS; Ft Rucker, AL; Ft Sill, OK; Ft Benjamin Harrison, IN; and Germany.

#### **I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

1. **FY 1978 and Prior Accomplishments:** The Military Applicant Profile (MAP) test was developed to screen out poor candidates for enlistment. Statistical personnel tests for the Joint US Army Recruiting Command/US Army Recruiting Program and for the Veterans' Educational Assistance Program were developed. Initial work was completed on factors affecting motivation to enlist in the Reserves. Factors affecting soldier reenlistment were identified. Guidelines for managing personnel turbulence in tank crews were developed resulting in approximately 50% improvement in tank gunnery performance. The effectiveness of the ROTC scholarship selection system was determined. Effects of different percentages of women in combat service support units on performance of those units was determined during extended field exercises. Results have influenced Army policy on the proportion of women to be assigned to combat service support units. Factors affecting soldier attrition during service in Europe were identified, thereby providing a basis for policy vitally affecting combat readiness of Army forces overseas. Support was provided to the President of the United States through the Commission on Military Compensation, the Viet-Nam era deserter program and the special Army discharge review program.

2. **FY 1979 Program:** Develop reading level tests for use in selecting recruits for Army service schools. Develop criteria for personnel management of armor crews and field artillery forward observers teams. Develop assessment model to select applicants for Officer Candidate School (OCS). Initiate research on integrating manpower and personnel costs into total systems affordability. Continue research on first-term enlisted attrition in US Army Europe.

Program Element: #6.17.31.A

DoD Mission Area: #222 Training and Personnel Technology

Title: Manpower and Personnel

Budget Activity: #2 - Advanced Technology Development

3. FY 1980 Planned Program: Conduct research to determine Army activities and procedures that have the greatest effect on recruitment and retention for the total Army force. Develop procedures for integrating manpower and personnel issues into the weapon system acquisition process and determine "total affordability" of the new system or organization. Initiate research to institutionalize and strengthen effective personnel management of Army units. Develop criteria for evaluating performance of Army recruiters. Develop factors which influence attrition of soldiers. Develop criteria which relates officer performance, recruiting, attrition and assignment policies. Develop commander's diagnostic methodology for use in evaluating command and staff performance at the unit level. Develop methodology to enhance command effectiveness using battalion command post exercises.
4. FY 1981 Planned Program: Conduct research on validation of methodology for assigning soldiers to crews/teams. Determine effects of current policy changes on soldier reenlistment and career retention. Complete development of requirements for cadet/junior officer career information system. Complete research on measures to be used in evaluating ROTC officers. Develop and evaluate methodology for improving unit cohesiveness and soldier adaptation to military service.

5. Program to Completion: This is a continuing program.



FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.32.A

Dod Mission Area: #221 - Medicine and Life Sciences

Title: Combat Medical Materiel

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	94	106	111	145		Not Applicable
A836	Combat Medical Materiel	94	106	111	145	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Requirement exists for development of simplified, rugged medical equipment for care of the combat casualty on the battlefield. Off-the-shelf equipment suitable for the purpose is not available for commercial sources.

C. BASIS FOR FY 1980 RDTE REQUEST: Funds are required to perform advance development of new and improved equipment for field medical support in a combat environment and to continue current development efforts in specific areas as required. A clinical analysis system for field use will continue to be developed. Work will continue to build a blood-screening device which provides an accurate method of counting blood cells.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
Funds (as shown in FY 1979 submission)	94	106	113	Continuing	Not Applicable

Slight decrease in FY80 funds results from minor program revisions.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.37.32.A

Sub Mission Area: #221 - Medicine and Life Sciences

Title: Combat Medical Materiel

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The combat medical materiel element supports research to develop medical, dental, veterinary, and pest management equipment necessary for delivery of health care to soldiers in the field. The approach is through design, fabrication, and testing of advanced development prototype equipment. The products of more fundamental exploratory development studies are analyzed, redesigned, and reduced for prototype suitability for user testing. Critical data required for assessing suitability for progression into engineering development is provided. This program is an aggressive research effort to develop new and improved medical field equipment for future incorporation into the casualty treatment system to meet projected modern warfare requirements.

G. RELATED ACTIVITIES: Related research, development, test and evaluation is conducted under Program Element 6.27.78.A, Combat Medical Materiel, and 6.47.17.A Combat Medical Materiel. Army programs are closely coordinated with Air Force and Navy medical materiel development programs via formal symposiums and informal contacts to insure that there is no duplication.

H. WORKED PERFORMED BY: Research is performed by in-house laboratory at the US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Completed operational testing of environmental protection container for medical supplies. Defined new parameters for the blood-screening device. Completed advanced engineering evaluations of the emergency sterilizer. Began pilot production for controlled release pesticide formulation. Work continued to develop a hardened prototype of the Flying Spot X-ray.
2. FY 1979 Program: Fabricate advanced prototypes of the blood-screening device. Complete fabrications and operational testing of the medical set, aidman bag. Operationally test the heated liner for the evacuation bag. Complete developmental testing of the controlled release pesticide formulations. Move elements of the field medical human body diagnostic examination and recording system to advanced development.
3. FY 1980 Planned Program: Continue acquisition of advanced development prototypes of medical materiel which contribute to rapid return to duty, far-forward resuscitation, protection and maintenance of the combat force. Operationally test one or more controlled release pesticide formulations. Develop a remote communications system with monitoring centers for use in isolated medical treatment areas.
4. FY 1981 Planned Program: Produce advance development prototypes of medical, dental, veterinary, and pest management materiel for maintenance of the combat force. Continue development on clinical analysis system for field use.
5. Program to Completion: This is a continuing program.

FY 1980 RDTF CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.39.A

Title: Human Factors in Training and Operational Effectiveness

DoD Mission Area: #222 - Training and Personnel Technology

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total	
							Estimated Costs	Not Applicable
A793	TOTAL FOR PROGRAM ELEMENT Human Factors in Training and Operational Effectiveness	0	1691	2309	3195	Continuing	3195	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:

1. User Problem: During the next five years, the US Army is fielding approximately twenty-five new major weapon systems. Deployment of these new weapons demands skilled, knowledgeable and dedicated soldiers. Furthermore, the operational concept and techniques of employment for those systems evolves concurrently with material development. This process must include the human operator as a component within the system.

2. Objective: Determine those human factors requirements associated with the operational concepts of employment of the weapons system. This includes a human factors evaluation of the system during developmental and operational tests at maneuver areas, training areas, firing ranges in CONUS and overseas, to include evaluation and diagnosis of human factors shortcomings in Army equipment/system maintenance and repair.

3. Products: (a) Crew operating procedures for the Army's main battle tank; (b) operating and maintenance concepts for the BLACKHAWK aircraft system, the advanced attack helicopter (AAH), and Stand-Off Target Acquisition System (SOTAS); (c) human factors procedures for increased effectiveness of automated communications systems and air defense systems; (d) methodology for predicting training requirements for new weapons systems.

4. How Used: Results are used by TRADOC system managers and DARCOM project managers in establishing operating and maintenance procedures, defining duties of individual crew members, and in assessing workload as a basis for determining numbers and skill levels of personnel needed for specific new weapon systems. Guidelines are furnished for human factors evaluation of weapons and equipment during operational testing. Demonstrated improvements in field operating procedures and techniques are incorporated into training and doctrinal material, e.g., night time surveillance patterns and nap-of-the-earth navigation.

C. BASIS FOR FY 1980 RDTF REQUEST: Trained personnel must reach the field together with the materiel if a weapon system is to be combat ready. There is a need to develop and evaluate better methods to relate a cost-effective training system to a new weapon system and to more accurately project manpower and skill requirements of the new system. Human factors evaluations are needed in conjunction with operational tests of major armor, infantry and artillery systems including the XM-1 and the Tactical Operations



Program Element: #6.37.39.A Title: Human Factors in Training and Operational Effectiveness  
 DoD Mission Area: #222 - Training and Personnel Technology Budget Activity: #2 - Advanced Technology Development

Systems as well as the Restructured Heavy Division. Human factors aspects of Advance Attack Helicopter and BLACKHAWK helicopter operation need examination along with BLACKHAWK maintenance workload.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL BUDGET REQUESTS: (\$ in thousands): This is a new program element created in response to Congressional guidance.

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
RDTE					
Funds (as shown in FY 1979 submission)	0	0	0	Continuing	Not Applicable

Funds requested for this program element are at approximately the same level as in FY 79 in the human factors portion of the program element from which this one is derived (6.37.43A, Education and Training).

E. OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.37.39.A

DoD Mission Area: #222 - Training and Personnel Technology

Title: Human Factors in Training and Operational Effectiveness  
Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The fielding of a large number of new weapon systems imposes a critical need to evaluate these systems such that soldier abilities and acquired skills are sufficient for effective tactical employment of the systems. This program covers research to match system demands with manpower and personnel capabilities. Major efforts focus on development of procedures for armor, air defense, artillery, infantry and automated or semi-automated tactical information systems; improved procedures for operating and maintaining rotary wing aircraft such as the BLACKHAWK; human factors operational test and evaluation for major weapons systems to identify improvements needed in operating procedures, doctrine, and manning levels; and the development of technology to predict training requirements for new systems in the early phases of system development.

G. RELATED ACTIVITIES: Coordination and dissemination/transfer of research is through participation in the Tactical Operations System Test Integration Working Group and the Panel for Helicopter Human Resources Research, through annual DoD budget and appropriation reviews, and through membership in tri-service committees such as the Human Factors Technical Advisory Group, the Human Factors Test and Evaluation Subgroup, and the DoD/NASA Simulation Working Group. Additional coordination will be obtained through participation in the NATO Working Group on Fidelity Requirements of Flight Simulation and The Technical Cooperation Program Panel on Human Factors in Command and Control Systems.

H. WORK PERFORMED BY: Contractors include: Human Resources Research Organizations, Killeen, TX; System Development Corporation, Leavenworth, KS; Vector Research, Ann Arbor, MI; Canyon Research Inc., Ft Rucker, AL; Institute for Research, State College, PA. In-house work is performed by the US Army Research Institute for the Behavioral and Social Sciences and its field units distributed at major installations, including Ft Benning, GA; Ft Bliss, TX; Ft Hood, TX; Ft Knox, KY; Ft Leavenworth, KS; Ft Ord, CA; Ft Rucker, AL; Ft Sill, OK; Ft Benjamin Harrison, IN; and Germany.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: (a) In close coordination with the Combined Arms Center, identified changes in division command and control procedures, and in personnel and skill requirements necessary to deploy the Tactical Operations System; (b) Completed development of integrated operator support for remotely monitored sensors. Skill performance aids, training packages and deployment doctrine resulted in a performance increase of up to 80%; (c) Developed and implemented a training program in battle planning and execution for battalion command groups using the Combined Arms Tactical Training Simulator (CATTS); (d) Developed procedures for maintaining helicopter pilot proficiency in operational units; (e) Conducted operational test and evaluation of training and personnel requirements for tank systems, Remotely Monitored Battlefield Sensor System (REMBASS), and helicopter gunnery.

2. FY 1979 Program: (a) Develop procedures for analyzing enemy movements through the airborne Stand-Off Target Acquisition System (SOTAS); (b) Complete research identifying operational requirements for nap-of-the-earth flight; (c) Conduct field research on team and operator performance in Tactical Fire Direction System (TACFIRE); (d) Conduct and complete field research on human factors in operational test and evaluation. This latter task is accomplished in coordination with the US Army Operational Test and Evaluation Agency.

Program Element: #6.37.39.A  
DoD Mission Area: #222 - Training and Personnel Technology

Title: Human Factors in Training and Operational Effectiveness  
Budget Activity: #2 - Advanced Technology Development

3. FY 1980 Planned Program: (a) Develop procedures for operating and maintaining armor, artillery, air defense and automated communications systems; (b) Conduct research on the operational concept and maintenance workload associated with the BLACKHAWK aviation system; (c) Conduct research on reduction of pilot workload for the Advanced Attack Helicopter; (d) Conduct human factors operational test and evaluation on the XM-1 Tank, Tactical Operations Systems and Restructured Heavy Division; (e) Complete development of handbook on human factors considerations in operational test and evaluation; (f) Develop a concept which relates a weapons system to a training system and to manpower/personnel projections for the time period when the weapons system will be used.
4. FY 1981 Planned Program: (a) Develop operating procedures for tactical management of intelligence collection systems; (b) Conduct research on operation and maintenance of aviation systems; (c) Conduct human factors analysis during operational test and evaluations on battlefield target acquisition systems, the Combat Electronic Warfare and Intelligence Group, and the Corps Tactical Operations Systems; (d) Develop handbook on human factors criteria for use in operational test and evaluation; (e) Develop a data base for use during manpower/personnel analysis in support of the Army System Acquisition Review Council (ASARC) process.

5. Program to Completion: This is a continuing program.



FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.42.A

DoD Mission Area: #211 - Electron Devices

Title: Advanced Electronic Devices

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion	Total	
							Estimated Costs	Not Applicable
	TOTAL FOR PROGRAM ELEMENT QUANTITIES	1227	700	1999	3449	Continuing		
DFY2	Advanced Electronic Devices	1227	700	1999	3449	Continuing		Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This advanced development program in electron devices, component assemblies and subsystems will provide new "technology insertion" into a substantial number of systems currently scheduled for or already under development or in initial production. Research and exploratory development programs that have successfully demonstrated feasibility will be carried into advanced development to meet user needs in an efficient and timely fashion. This program will permit substantial performance or cost improvement to take advantage of major technology advances that have occurred in parallel with ongoing systems developments so that technologically obsolete systems will not be fielded. Emphasis will be placed on insuring performance capability, while stressing reliability, cost effectiveness, and modular packaging. The approaches pursued include selection of optimum component technology and solution of module interface problems based on defined user needs. Generally more than one system is impacted so that development costs for these items cannot be borne by a single system.

C. BASIS FOR FY 1980 RDTE REQUEST: A significant portion of the next land war will be fought under conditions of severe limited visibility. The Army will need a low cost capability to detect and recognize small targets through smoke, adverse weather and camouflage. Millimeter wave device development is being accelerated because of its ability to penetrate smoke and fog and new concepts for decreasing costs of devices are being pursued. The development and fabrication of low cost Gunn oscillators at 60, 94 and 120 GHz and high power coherent sources will be continued and devices obtained will be evaluated in prototype tank-mounted radars (STARTLE) and terminal homing Beam Rider Systems. A lightweight, 1.0 kW peak power, 3.2 millimeter wave tube development will be started for use in an Remotely Piloted Vehicle (RPV) borne millimeter wave and target acquisition radar. At the present time, US forces have a limited capability to determine range to targets and terrain features; in addition, these devices are too heavy and voluminous. A program will be started to provide for a compact nanosecond pulser for laser target designators/range finders for portable systems. The pulser weight will be reduced from 25 to 3 kg and the volume from 3600 to 500 cubic cm. The tempo of modern battle demands timely information from all sources, rapidly processed and made available to the Commander. Development will continue on low cost, small, low power charge coupled devices for signal processors for radar, remote sensors and secure communications. The development of sunlight legible, high contrast, multi-color display for the AN/APR-39 radar warning receiver will be continued. Development of the 1 cu inch tactical miniature crystal oscillator for the Global Positioning System (GPS) manpack receiver will be completed. Advance development of an L-Band, fast frequency hopping synthesizer for covert anti-jam data links will be started.

Program Element: #6.37.42.A  
 DoD Mission Area: #211 - Electron Devices

Title: Advanced Electronic Devices  
 Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTE	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
Funds (as shown in FY 1979 submission)	1227	700	1350	Continuing	Not Applicable

The \$650K increase for FY80 represents increased funding for three programs (Solid State Low Cost Millimeter Wave Devices, High Contrast CRT Display, and Low Cost Electronic Warfare Signal Processing Modules).

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.37.42.A

DoD Mission Area: #211 - Electron Devices

Title: Advanced Electronic Devices

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The objective is to provide advanced development models of electronic components, assemblies and subsystems for application in military systems. Proven device feasibility will be directed to specific system applications. The approach will include the development of sufficient numbers of models/modules to determine reliability, performance, reproducibility with major emphasis on greater commonality of application and lower life cycle costs. This program is critical to the improvement in fielded Electronic Warfare (EW), Radar and Communications Systems.

G. RELATED ACTIVITIES: Coordination is achieved with other Government agencies through participation in the activities of the Department of Defense Advisory Group on Electron Devices (AGED). Inter-service coordination and program cooperation are also directly derived from joint preparation of the Technology Coordinating Paper on Electronics which assesses the technical program, goals and potential pay-off from the tri-service total investment of electronics technology base funds. Program Element 6.27.05-A, Electronics and Electron Devices, provides the Exploratory Development effort for this program.

H. WORK PERFORMED BY: The Electronics Technology and Devices Laboratory, ERADCOM, Fort Monmouth, NJ. This Laboratory is scheduled to use approximately 20% of the program funds in-house. The principal contractors are: Sanders Associates, Merrimack, NH; Varian Associates, Palo Alto, CA; Hughes Aircraft, Fullerton and Torrance, CA; and Watkins-Johnson, Palo Alto, CA.

#### 1. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Initial models of the AN/TPQ-37 radar transmitter were evaluated and integration of tubes and transmitter subsystem started. First models of the mini Traveling Wave Tube (TWT) jammer package were evaluated. Higher efficiency Infrared (IR) sources were evaluated for effectiveness. Effort on sunlight legible display modules for Tactical Fire Direction System (TACFIRE) has begun. Design and characterization of the discrete Fourier Transform Signal Processing Module for radar, sensors and secure communications equipment has started. Finalization of the thermal and mechanical design of the one cubic inch tactical miniature crystal oscillator (TMXO) has been started. Efforts have been initiated to fabricate prototype millimeter wave oscillators consisting of single and multiple QW devices for 60, 94 and 140 GHz operation to be applied to millimeter wave radar, terminal homing for projectiles and missiles and secure communications.

2. FY 1979 Program: The ruggedization and improvement of the high power final output TWT for the Artillery Locating Radar, AN/TPQ-37, will be completed. The existing artillery locating systems with Mean-Time-Between-Failures (MTBFs) less than 100 hours will be upgraded by the arc-free TWTs which are to be interfaced with reliable solid state modulator and microprocessor controlled circuitry. The advanced development of the low cost, mini TWT, expendable jammer package capable of being delivered by mortars and shells will be completed. The high temperature graphite IR source program to develop a higher power output and increased long wavelength source for the protection of Army aircraft against advanced IR heat seeking missiles will be completed. The development of an operating discrete Fourier transform subsystem using charge coupled devices (CCDs) for real time signal processors for radar, remote sensors and secure communications will be continued. Development will continue on a multi-year program to develop low cost EW signal processing modules in parallel with a basic EW system so that by the time the system is



Program Element: #6.37.42.A  
DoD Mission Area: #211 - Electron Devices

Title: Advanced Electronic Devices  
Budget Activity: #2 - Advanced Technology Development

ready for production it can be built using the latest technology. The one cubic inch TMO development will be continued with major emphasis on packaging and finalization of the thermal and mechanical design. Ceramic microelectronic and outer case enclosures will be developed to improve the reliability and extend the useful life of the tactical miniature crystal oscillator (TMO) by reduced power aging.

3. FY 1980 Planned Program: A growing realization by the United States Army indicates the necessity to fight a significant portion of the next land war under conditions of severe limited visibility. The Army will need a low cost capability to detect and recognize small targets through smoke, adverse weather and camouflage. Millimeter wave device development is being accelerated greatly because of its ability to penetrate smoke and fog, and new concepts for lowering the costs for components are being pursued. The potential for cost reduction will also be accelerated by producing some system in large quantity in either a future version of the Surveillance and Target Acquisition Radar (STARTLE) or terminal seekers for tactical missiles. A lightweight, 1.0 kw peak power, 3.2 millimeter wave tube development will be started for high resolution tank mounted or Remotely Piloted Vehicle (RPV) borne radar. The development and fabrication of low cost Gunn oscillators at 60, 94 and 120 GHz and high power coherent sources will be continued and devices obtained will be evaluated in prototype tank mounted radars and terminal homing systems. At the present time, US forces have a limited capability to determine range to targets and terrain features; in addition, these devices are too heavy and voluminous. This limitation seriously affects the ability to place timely and effective fires on known enemy locations and targets of opportunity. A program will be started to provide for a compact nanosecond pulser for laser target designators/rangefinders for portable systems. This program will reduce the pulser's weight from 25 to 3 kg and volume from 3600 to 500 cubic cm. The tempo of modern battle demands timely information from all sources, rapidly processed and made available to the Commander. The development of low cost, small, low power analog charge coupled devices (CCDs) to replace bulky, high power consumption, digital processors for real time signal processors for radar, remote sensors and secure communications will be continued. The development of a high contrast CRT display module, providing a sunlight legible, radar, remote sensors and secure communications will be continued. The development of a high contrast CRT display module, providing a sunlight legible, multicolor display for the radar warning receiver AN/APR-39 will be continued. The development of low cost EM signal processing modules will continue in parallel with a basic EW system so that by the time the system is ready for production it can be built using the latest technology. The advanced development of a 1 cu inch tactical miniature crystal oscillator to be used in the Global Positioning Satellite (GPS) manpack receiver operational tests will be completed. Twenty TMO packages verifying the validity of design will be fabricated and serve as a basis for initiation of a manufacturing methods and technology (MM&T) program. Advanced development models of surface acoustic wave (SAW) fast-frequency-hopping synthesizers operating at L-Band will be fabricated, reflecting a high level of subsystem optimization and cost effectiveness for covert anti-jam data links.

4. FY 1981 Planned Program:

a. Effort will continue on the development of the 1.0 kw, 3.2 millimeter wave tube for adaption to Remotely Piloted Vehicle (RPV) beam rider and tank-mounted radars. The development of prototype low noise Gunn and high power coherent oscillators at 60 and 94 GHz will be completed and high performance, cost effective, rugged oscillator assemblies made available for system

Program Element: #6.37.42.A

DoD Mission Area: #211 - Electron Devices

Title: Advanced Electronic Devices

Budget Activity: #2 - Advanced Technology Development

evaluation. The compact nanosecond pulser for laser target designators/rangefinders for portable systems will be completed and effort will be initiated on a nanosecond pulser for 3.2 millimeter wave radar for the mini Remotely Piloted Vehicle (RPV). The development of low cost, small, low power analog charge coupled devices (CCDs) in a discrete Fourier transform subsystem for application in real time signal processing for radar, communications and remote sensors will be completed. The development of a high contrast cathode ray tube (CRT) display module, providing a sunlight legible, 2 color display for the radar warning receiver AN/APR-39 will be completed. The development of specific circuit modules for general purpose electronic warfare (EW) signal processing will continue using the latest technology and Computer-Aided Design techniques to implement the EW equipment design. The program to develop an L-Band surface acoustic wave (SAW) oscillator and cost effective frequency synthesizer for covert anti-jam data links will be completed.

b. A two-year program will be initiated to prove in a family of low cost microcircuit compatible ceramic flatpack quartz resonator enclosures having improved stability, reliability, and ruggedness for use in data links, communication and navigation equipment. A program will be initiated to develop low cost Very Large Scale Integrated Circuits (VLSI) Communication-Electronic modules for "technology insertion" into sensor, RPV and target acquisition systems and replacing large computational and processing subassemblies to lower cost and improve systems logistics. A low cost jammer tube development will be started using laser-cut substrate technology and a high current cathode for 2,000 hour life for use in an advanced AN/ALQ-136. A program will be started to develop a 60-500 Mhz, 1 kW communications jammer using electron beam semiconductor amplifiers. A four-year program to improve the Mean-Time-Between-Failure (MTBF) for the AN/TPQ-36 and -37 from 250 to 800 hours will be initiated. Basic building block power supply and switching modules will be designed, constructed and serve as basic modules for various Army systems.

5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.43.A

DoD Mission Area: #222 - Training and Personnel Technology

Title: Education and Training

Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978		FY 1979 Estimate	FY 1980		FY 1981 Estimate	Additional to Continuing	Total Estimated Costs	Not Applicable	Not Applicable
		Actual			Estimate	Continuing					
A794	TOTAL FOR PROGRAM ELEMENT	5835		6178	8370		8623				
	Individual Training and Combat	5835		6178	8370		8623				
	Unit Training										

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:

1. User Problem. The Army requires new and improved concepts and technology for individual and unit training to assist unit commanders in the field in performing their mission more effectively.
2. Objectives. To develop training technology to enhance and sustain the competence, motivation and performance of individuals and units; to improve training methods, procedures and materials to support Army commanders in achieving their training objectives; and to enhance combat arms and combined arms training including armored crew training, aviation crew training, skill retention and on the job training in units.
3. Products. Refresher training programs to maintain soldier skills. Training guidelines for maintaining helicopter aircrew proficiency. Training program for armored crewmen including crew cross-training program. Guidelines for preparation of Army Training and Evaluation Program (ARTEPs) for Infantry, air defense, and artillery units. Methodology for predicting skill retention.
4. How Used. This work supports Army-wide requirements for development of ARTEPs which realistically describe combat tasks to be performed by Army units. This research is the basis for the unit commander's evaluation of combat readiness of his command. The work is used by TRADOC in constructing advanced training in combat and technical skills for use in schools and operational units. Results are also applied to refresher training programs conducted within units. The results guide the management of unit training by helping the commander determine training needs and training loads.
- C. BASIS FOR FY 1980 RDTE REQUEST: Determine the most effective and economical approach to training in the Army service schools and operational Army units. Develop training materials for teaching military occupational specialty (MOS) skills for Active, Reserve and National Guard soldiers in the unit. Evaluate ARTEPs for Armor, Infantry, Field Artillery and Air Defense Artillery units. Validate unit training concepts and procedures for transferring training conducted in Army Service Schools to unit training conducted in the field. Develop ARTEPs for combat service support units (Medical, Signal, Transportation, Maintenance, Military Police). Place increased emphasis on prediction and maintenance of skill retention of individuals in units.



Program Element: #6.37.43.A

DoD Mission Area: #222 - Training and Personnel Technology

Title: Education and Training

Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUPPLIES: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Not Applicable
	5600	7848	10389	Continuing		

Changes in this program element are primarily a result of restructuring in response to Congressional guidance and requirements to prepare training packages and management systems for armored crews and pilots in operational units.

E. OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.37.43.A

DoD Mission Area: #222 - Training and Personnel Technology

Title: Education and Training

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: Individual and unit training must be relevant, efficient and economical to ensure combat readiness. To achieve this, training research and development must be continued and expanded through field and laboratory experiments, performance evaluations, and statistical analysis. Prototype training/assessment materials include: (1) methods and materials to decentralize training; (2) tools to enable supervisors and commanders to be effective trainers and managers; (3) on-the-job refresher training and cross-training programs to enhance soldier skills; (4) assessment measures for individuals and units and (5) materials to develop and maintain effective armor and aviator crews.

G. RELATED ACTIVITIES: This program is coordinated with Air Force Program Element 6.37.51F, Training and Education Innovations; and Navy Program Elements 6.37.20N, Education and Training and 6.37.38A, Non-Systems Training Device Development. Its products are coordinated with US Army Training and Doctrine Command and operational troop commands. Interservice coordination is effected through tri-service technical coordination reviews, budget and apportionment reviews under Department of Defense (DoD) auspices, and participation in tri-service development of DoD Technology Coordinating Papers, as well as tri-service and international committees in such areas as educational technology and training simulation.

H. WORK PERFORMED BY: Contractors include: Litton Systems, Inc., Beverly Hills, CA; Data Design Laboratories, Cucamonga, CA; Kinton, Inc., Alexandria, VA; Applied Science Assoc., Inc., Valencia, PA; Human Resources Research Organization, Alexandria, VA. In-house research is performed by the US Army Research Institute for the Behavioral and Social Sciences, Alexandria, VA, and its field units distributed at major installations, including Ft Benning, GA; Ft Bliss, TX; Ft Hood, TX; Ft Knox, KY; Ft Leavenworth, KS; Ft Ord, CA; Ft Rucker, AL; Ft Sill, OK; Ft Benjamin Harrison, IN; and Germany.

#### 1. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS

1. FY 1978 and Prior Accomplishments: Developed guidelines for commanders to produce, validate and utilize Skill Qualification Tests. Developed and introduced procedures for training basic rifle marksmanship which resulted in reducing annual ammunition costs by 6.9 million dollars. Developed and introduced Army-wide a self-paced Map Interpretation and Terrain Analysis (MITAC) course, reducing nap-of-the-earth helicopter navigation errors by 33%. Developed training guidelines for maintaining helicopter pilot proficiency in operational units. Developed individual extension training packages for infantry units.

2. FY 1979 Program: Develop program for training managers and supervisors to conduct individual training in units. Develop guidelines for improving tank platoon gunnery. Develop individual/crew training for the Infantry Fighting Vehicle (IFV), AN/TPQ-36 radar, Ground Laser Locator Designator, and armor and aircrew personnel. Develop and evaluate requirements for critical technical maintenance Military Occupational Specialties.

Program Element: #6.37.43-A  
DoD Mission Area: #222 - Training and Personnel Technology

Title: Education and Training  
Budget Activity: #2 - Advanced Technology Development

3. FY 1980 Planned Program: Design Army training program for tank gunnery training. Initiate research to determine selection requirements for entry into the Army aviation pilot training program. Develop procedures for training and assigning individuals to aircraft crews. Initiate research to determine criteria for evaluating performance in critical maintenance jobs. Develop guidelines for use by managers in determining frequency of aircrew refresher training needed to sustain proficiency. Develop guidelines for ARTEPs in conjunction with TRADOC scenarios for combat units in order to evaluate readiness of those units. Evaluate combat unit training in Army units in CONUS and overseas. Conduct research on how to efficiently export training technology from the Army Service Schools to field unit commanders.

4. FY 1981 Planned Program: Validate training management systems in units. Conduct field test on effectiveness of refresher training on maintenance of MOS skill proficiency. Demonstrate on-the-job training in artillery, air defense and armor units. Conduct research and development to institutionalize combat unit training in the field by exporting training technology from the Army Service Schools.

5. Program to Completion: This is a continuing program.



**FY 1980 RDTF CONGRESSIONAL DESCRIPTIVE SUMMARY**

Program Element: #6.37.44.A Title: Training Simulation  
 Sub Mission Area: #222 - Training and Personnel Technology Budget Activity: #2 - Advanced Technology Development

**A. RESOURCES (PROJECT LISTING): (\$ In thousands)**

Project Number	Title	FY 1978		FY 1979		FY 1980		FY 1981		Additional to Completion Continuing	Total Estimated Costs	
		Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate		Not Applicable	Not Applicable
A795	TOTAL FOR PROGRAM ELEMENT Training Simulation	500	500	1080	1080	1065	1065	1900	1900	Continuing	Not Applicable	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:**

1. User Problem: The soldiers who will operate the Army's new weapon systems in wartime require extensive training to insure maximum combat effectiveness of the systems. Because actual operation of the systems is very expensive, major savings can be achieved by the use of simulation in peacetime training. In addition, simulation may be the only technique for training combat arms units in some aspects of warfare; thus simulation becomes essential for insuring the combat readiness of our forces.

2. Objectives: (a) Develop engagement simulation training and evaluation technology. (b) Develop concepts and requirements for simulator and training devices for rotary wing and armor crew training. (c) Develop computer embedded training which utilizes the computer capability of operational systems without detriment to the systems.

3. Products: The following training packages will be implemented by the Army: (a) Engagement simulation technology (visual and laser) for Army Training and Evaluation Programs (ARTEP). (b) Training program that simulates live fire tank gunnery. (c) Simulator for full crew armor training. (d) Aviator training simulator requirements and training program. (e) Guidelines for developing simulator and training device requirements. (f) Procedures for conduct of maintenance training simulation. (g) Training package for implementing Multiple Integrated Laser Engagement Simulation system (MILES) for Infantry, Armor and Anti-Armor. (h) Exercise control system for the National Training Center at Ft Irwin, California.

4. How Used: The Training and Doctrine Command (TRADOC), the Project Manager for Training Devices (PM TRADE) and the TRADOC System Manager for Tactical Engagement Simulation (TSMES) are the prime users of this research. Specifications will be provided to PM TRADE for use in developing and evaluating training devices and simulators, such as the Multiple Integrated Laser Engagement System (MILES), Air-Ground Engagement Simulation (AGES), Armor Full Crew Research Simulator (AFCRS), Infantry Remoted Target System (IRETS) and many others. Training approaches for engagement simulation and for aviator and armor crew training will be provided to TRADOC for institutionalization. A training system will be established for fielded TACFIRE at Division and Battalion Artillery levels.

C. BASIS FOR FY 1980 RDTF REQUEST: Develop implementation concepts for engagement simulation training for MILES. Develop training packages for engagement simulation training for use at the National Training Center at Ft Irwin, California. Define training capabilities needed in advanced helicopter flight training simulator for the prototype advanced Attack Helicopter. The embedded

Program Element: #6.37.44.A  
DoD Mission Area: #132 - Training and Personnel Technology

Title: Training Simulation  
Budget Activity: #2 - Advanced Technology Development

training system for the Army Tactical Fire Control System (TACFIRE) will be further developed to accept team training as well as individual training. Define requirements for simulation training for critical maintenance skills.

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL BUDGET REQUESTS: (\$ in thousands)

RDTE Funds (as shown in FY 1979 submission)	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Not Applicable
	485	450	500	Continuing		

This program element is restructured in response to Congressional guidance. Increase in FY 80 is based on need for a prototype system for the development and utilization of training devices and simulation for the US Army.

E. OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.17.44.A  
Bob Mission Area: #132 - Training and Personnel Technology

Title: Training Simulation  
Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The application of simulation technology is based on a need to satisfy requirements from TRADOC and major Army commands. Research in training and simulation is designed to (1) increase effectiveness of field exercises using realistic engagement simulation training programs such as REALTRAIN and MILES; (2) generate field simulations which integrate new equipment doctrine; (3) develop simulator requirements and training approaches for training Army aviators and armor crews; (4) develop computer aided instruction packages for Army units; (5) develop embedded training approaches using the operational system computer itself as a device for team training and for computerized performance testing.

G. RELATED ACTIVITIES: Related research activities are coordinated on a formal basis through DoD-wide topical reviews, Training and Personnel Technology Conferences and Inter-service planning committees. The "Integrated DoD Plan for R&D on Computers in Education and Training" provides a five year planning paper for computer instruction research which is updated annually by the DoD Task Group on Computers in Education and Training. The Joint Technical Coordinating Group - Simulators and Training Devices, and the Technical Advisory Group for Maintenance Training serve as coordinating mechanisms for DoD-wide simulation research. Efforts also are coordinated with PH TRADE, NTEC (Naval Training Equipment Center) and with the TSM-NTC (TRADOC System Manager for the National Training Center). Scientific conferences and the Army Science Board serve as technical peer evaluation and information exchange mechanisms.

H. WORK PERFORMED BY: Contractors include: Northwest Regional Education Lab., Portland, OR; Klinton, Inc., Alexandria, VA; Human Sciences Research, Inc., McLean, VA. In-house work is performed by the US Army Research Institute for the Behavioral and Social Sciences and its field units distributed at major installations, including Ft Benning, GA; Ft Bliss, TX; Ft Hood, TX; Ft Knox, KY; Ft Leavenworth, KS; Ft Ord, CA; Ft Rucker, AL; Ft Sill, OK; Ft Benjamin Harrison, IN; and Germany.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: (a) Developed and implemented Army-wide combat engagement simulation training for Infantry, armor and combined Arms units with extension to air-ground engagement and armored cavalry units; (b) evaluated functional capabilities requirements for armor full crew research simulators; (c) developed general requirements for a rotary wing pilot research simulator; (d) developed simulator concept for training artillery forward observers with reduced ammunition expenditures as a major by-product; (e) developed an approach for specifying simulation and training requirements in the early stages of weapon system development; (f) developed computer-assisted instruction materials for Field Artillery forward observer training; (g) conducted cost and training effectiveness analysis (CTEA) for AN/TSQ-73 air defense system; (h) evaluated embedded training concept for tactical data systems; (i) completed prototype TACFIRE (tactical fire control system) embedded training package for individual operators; (j) completed prototype training device assessment model; (k) completed evaluation of computer-assisted instruction for basic skills.

2. FY 1979 Program: (a) Develop procedures for integrated engagement simulation into battalion ARTEPS for the National Training Center at Fort Irwin, CA and for the US Army Training and Doctrine Command; (b) develop student pilot selection procedures, using the UM-1 pilot training simulator, to improve student completion rate and reduce training costs; (c) develop requirements for a tank gunnery simulator for the XM-1 tank; (d) develop users handbook for revised training device assessment procedures; (e) validate air defense training systems CTEA model in a simulation setting; (f) develop embedded training Skill Qualifications



Program Element: #6.37.44.A

Bob Mission Area: #132 - Training and Personnel Technology

Title: Training Simulation

Budget Activity: #2 - Advanced Technology Development

Test for TACFIRE; (g) develop procedures to specify training equipment needs in support of Army weapon systems; (h) evaluate cost and training effectiveness of computer-assisted instruction for forward observer training.

3. FY 1980 Program: (a) Field test engagement simulation procedures for a battalion at the National Training Center at Ft Irwin, California; (b) validate new simulator based pilot screening program to reduce flight training; (c) develop additional training programs for the armor full crew simulator; (d) refine and revise embedded training software for computer managed instruction in TACFIRE and TOS (Tactical Operations System); (e) evaluate embedded team training concept for TACFIRE; (f) develop automated job aids for production of embedded training instructional materials; (g) conduct, in support of TRADOC, cost-training effectiveness analysis for PATRIOT air defense system; (h) establish procedure for identifying maintenance training needs which will benefit from simulation training; (i) evaluate computer based simulation packages for training in maintenance of tactical radios; (j) conduct analysis of Army battalion-level manual battle simulations.

4. FY 1981 Planned Program: (a) Integrate engagement simulations for infantry, armor, air defense, and armored cavalry into battalion and higher level ARTEPS; (b) conduct field evaluation of new simulator-based aviator selection and assignment program; (c) evaluate BLACKHAWK crew training simulation; (d) develop prototype computer-based instructional delivery system; (e) develop and evaluate advanced instructional computerized programs.

5. Program to Completion: This is a continuing program.

FY 1980 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.48.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstrations

Title: Advanced Development of Automatic Test Equipment and Systems  
Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs
	<u>TOTAL FOR PROGRAM ELEMENT</u>	<u>930</u>	<u>0</u>	<u>2800</u>	<u>9105</u>		<u>Not Applicable</u>
AJ29	Automatic Test Support Systems (ATSS)	930	0	2300	8205	Continuing	Not Applicable
DZ44	ATSS Lang Util & Stand	0	0	500	900	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** This program addresses the critical Army need for the development of General Purpose Automatic Test (ATE) hardware and software, which will be incorporated into the field support packages of numerous Army weapons, electronic, and communications systems. New systems under development are incorporating advanced electronic circuit technology with complex large scale integrated circuits that can no longer be totally supported with conventional test, measurement, and diagnostic equipment. The ATE systems, ancillary items, and software tools resulting from this effort will enable relatively low-skilled electronics technicians to troubleshoot and repair highly sophisticated electronic systems which cannot effectively be tested/repaired by other means. A significant portion of the program funds will be applied toward cost sharing in joint programs for ancillary items, and toward collective Army/Air Force development of hardware. The advantages of utilizing automatic test equipment include: reduces incorrect diagnosis and unnecessary repairs; reduces diagnostic time and manpower requirement; reduces cost of developing and procuring special, peculiar, and common test equipment; and reduces the necessity of large numbers of skilled diagnosticians.

**C. BASIS FOR FY 1980 RDTE REQUEST:** Survey Army-wide requirements to determine the design of Automatic Test Equipment to support a broad class of systems at organizational and direct support maintenance levels. Initiate development of a "suitcase" type of automatic test equipment which will provide go, no-go test capability for organizational level of maintenance. This development model will isolate malfunctioning weapon systems to a removable module.

Program Element: #6.37.48.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstrations

Title: Advanced Development of Automatic Test Equipment and Systems  
Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total	
					Estimated Cost	Not Applicable
NOTE Funds (as shown in FY 1979 submission)	700	2047	6839	Continuing		

The increase in FY 1978 funds supported the investigation of industry's technical capability to support Automatic Test Equipment. The decrease in FY 1980 funds will delay awarding an Advanced Development contract for a direct support/organization (ORC/DS) level suitcase tester and evaluation of new initiatives in the areas of software utilization and standard language implementation. Both projects in the Program Element are restarts after a one year delay due to Congressional denial of funds in FY 1979.

E. OTHER APPROPRIATION FUNDS: (\$ in thousands): Not Applicable.



Program Element: #6.37.48.A

Title: Advanced Development of Automatic Test Equipment and Systems

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstrations

Budget Activity: #2 - Advanced Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: Substantive advances in technology have made possible development of highly complex weapons systems with greater performance capability. In turn, these systems require the development of correspondingly more complex test and support equipment. Advanced computer controlled automatic test equipment and simpler automatic test program generation systems must be developed to keep pace with communications, electronics, optical, and laser development. The goals of the program are to develop a bench type automatic tester able to fault isolate printed circuit boards at the direct support maintenance level; development of a low cost, micro-processor controlled, "suitcase" automatic tester which would provide a go, no-go test for communications-electronic equipment at direct support and organizational maintenance levels; and development of automatic test equipment that is missile system peculiar. Other efforts will include the development of standards, guidelines, and mechanical aids required by Army system developers who will be supported by automatic test equipment.

G. RELATED ACTIVITIES: Program Elements (PE's) 6.27.79.A (Test Measurement and Diagnostic Technology) and 6.47.46.A (Automatic Test Support Systems) accomplish the exploratory and engineering development work, respectively, for work covered under this program. PE 6.47.46.A also supports Joint Air Force - Army participation leading to development of a common core automatic test system.

H. WORK PERFORMED BY: In-house work is performed by the US Army Communications Research and Development Command, Ft Monmouth, NJ. Contractors are: Emerson Electric, St Louis, MO; RCA Corporation, Burlington, MA; University of Pennsylvania, Philadelphia, PA.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: Completed Operational Test (OT 1) of concept of applying Automatic Test Equipment (ATE) at the General Support Field Maintenance Level. Provided technical support to Army Program Managers (PM's) in the integration of ATE into their systems. Convened a Special Task Force of representatives from the various Army equipment developer and user commands to determine the technical capabilities of industry in Automatic Test Equipment and to determine Automatic Test Equipment requirements of the Army. As a result of the Task Force effort, the need for intensive, centralized management and augmented funding for ATE was validated. A Required Operational Capability (ROC) for the General Support Automatic Test Equipment was initiated, and the need for DS/ORG (direct support/organizational) suitcase type tester validated. The Outline Development Plan for a small suitcase-sized tester program was completed. Continued contractual effort to reduce test software development costs, and to determine the methods of implementing a Department of Defense (DOD) standard automatic test equipment language.

Program Element: #6.37.48.A

DoD Mission Area: #244 - Mobility and Logistics  
Technology Demonstrations

Title: Advanced Development of Automatic Test Equipment and Systems  
Budget Activity: #2 - Advanced Technology Development

2. FY 1979 Program: Continue efforts toward the definition of a Direct Support Suitcase Tester needs/capabilities; convene an In-Process Review (IPR) seeking approval to enter accelerated development and acquisition in 1st Qtr FY80; complete formal arrangements to participate and cost share in an ongoing Air Force General Support Type Automatic Test Equipment Development; continue work in the highly promising and important areas of automatic test program set generation and software transportability.
3. FY 1980 Planned Program: Award accelerated Advanced Development contract for the direct support/organizational (DS/ORG) Level Suitcase Tester. Continue participation in the Air Force General Support (GS)-Level Type Automatic Test Equipment (ATE) Advanced Development Program and press initiatives in the areas of software utilization and standard language implementation. Participate in Joint Logistics Commanders (JLC) Panel on Automatic Testing assigned areas.
4. FY 1981 Planned Program: Complete development of hardware design and prototype fabrication DS/ORG ATE. System software and prototype test program sets will be developed. Award contract for prototype advanced stimulus and measurement modules. Begin full scale participation in Joint Army-Air Force ATE program, leading toward development of Army responsive specifications necessary to start Engineering Development of Army GS/ATE in FY 1982. Continue work leading to establishment of full transportability of ATE software and efficiency of test program set generation and continue JLC taskings in areas of ATE standards and tools.
5. Program to Completion: This is a continuing program directed toward solving the critical need for development of general purpose automatic test hardware to support highly sophisticated Army weapons and electronic-communications systems.

FY 1980 RDTF CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.49.A

DoD Mission Area: #212 - Electronic Warfare Technology

Title: Technical Vulnerability Reduction  
Budget Activity: #2 - Advanced Technology Development

A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
	TOTAL FOR PROGRAM ELEMENT	0	1500	2600	2975		
D462	Technical Vulnerability Reduction	0	1500	2600	2975	Continuing	Not Applicable

**B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:** The objective of this program is to provide a US Army Materiel Development and Readiness Command (DARCOM) focal point for improving and/or incorporating a Counter-Countermeasures (CCM) capability in the development of Army systems based on known and projected enemy countermeasures (CM) threats. Through performance of detailed technical analyses, evaluations and studies, coordination, and integration of various Department of Defense (DoD) agency efforts to address CM/CCM, and presentation of findings to top level management this program ensures that CM threats/CCM alternatives are addressed early and throughout the life cycle of Army materiel systems. The program also attempts to enhance the Research and Development (R&D) community's awareness of the CM threat and the necessity for early pursuit of appropriate CCM technology.

**C. BASIS FOR FY 1980 REQUEST:** Complete and publish a comprehensive "How to" manual for Army-wide CM/CCM management; continue effort to integrate CM/CCM into models/scenarios; upgrade signature program; assess susceptibility/vulnerability of critical electro-optical (EO), and laser systems to CM including smoke technology; assess technical vulnerability of US equipment to multispectral screening technology; evaluate CM to millimeter wave (MM wave) technology; initiate, participate in, and monitor external contracts for Office of the Secretary of Defense (OSD) directed definition studies intended to provide future CCM improvements to Stand-Off Target Acquisition System (SOTAS), Remotely Piloted Vehicles (RPV), and PATRIOT (\$1000K funding level directed by OSD); assess selected weapons systems with emphasis on Command, Control, and Communications (C<sup>3</sup>).



Program Element: #6.37.49.A Title: Technical Vulnerability Reduction  
 DoD Mission Area: #212 - Electronic Warfare Technology Budget Activity: #2 - Advanced Technology Development

D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost
RDTE					
Funds (as shown in FY 1979 submissions)	0	2000	2000	Continuing	Not Applicable

FY 1979 funds were decremented by \$500K and reprogrammed to higher priority programs. This caused a decrease in external support to Surveillance Target Acquisition Radar for Tank Location and Engagement (STARTLE), Heliborne, Laser, Fire and Forget Missile/Advanced Attack Helicopter (HELLFIRE/AHH), Battlefield Surveillance Target Acquisition Radar (BSTAR), Standoff Target Acquisition System (SOTAS), XM1 tank, and Remotely Piloted Vehicles (RPV) planned system assessments.

FY 1980 funds were increased by \$600K to fund Office, Secretary of Defense (OSD) directed special study effort on SOTAS, RPV, and PATRIOT.

E. OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.17.49.A

DoD Mission Area: #212 - Electronic Warfare Technology

Title: Technical Vulnerability Reduction

Budget Activity: #2 - Advised Technology Development

F. DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to perform as the US Army Materiel Development and Readiness Command (DARCOM) Countermeasures (CM)/Counter-Countermeasures (CCM) focal point for ensuring that technical CM/CCM are properly evaluated and integrated with tactical and threat considerations by interfacing with US Army Training and Doctrine Command (TRADOC) and US Army Intelligence and Security Command (INSCOM), respectively, throughout the materiel acquisition process. The systems to be addressed are those involved in or relying upon the transmission, emission, reception, or reflection of signals by electromagnetic, sonic, seismic, olfactory, or optical means. The Office will review and integrate the CCM efforts of various DARCOM agencies to ensure coverage of critical systems and eliminate redundancy wherever possible. The technical aspects of CM/CCM will be directly handled by conducting studies of selected systems/developmental items, with the goal being the maintaining of the viability of US systems on the realistic battlefield.

G. RELATED ACTIVITIES: The TRADOC/DARCOM/INSCOM interaction will assure that the newest technologies are combined with optimized tactics and up-to-date intelligence to provide effective and survivable battlefield weapons systems. This office, as the DARCOM CCM manager, will closely interface with DARCOM's vulnerability assessment activities, research and development laboratories, and product/project managers to preclude duplication of effort and make maximum use of existing capabilities. This will be performed by integration with the Office of Missile Electronic Warfare (OMEW) in Program Element (PE) 6.37.18.A/D267 (Missile Vulnerability/Susceptibility), US Army Electronics Warfare Laboratory (EWL) in PE 6.37.18.A/D262 (Nonmissile Vulnerability/Susceptibility), US Army Missile Research and Development Command (MIRADCOM) in PE 6.37.18.A/D235 (Missile CCM Technology), and Office of the Test Director (OTD) in PE 6.37.18.A/D190 (Tri-Service Electro-Optical Weapons Vulnerability/Susceptibility).

H. WORK PERFORMED BY: The organization having responsibility for this program is the DARCOM CM/CCM office located at the US Army Electronics Research and Development Command (ERADCOM), Adelphi, MD.

#### I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1978 and Prior Accomplishments: This project began as a continuation of the PATRIOT Vulnerability Studies Office which investigated vulnerability reduction to the PATRIOT Missile System and was funded in prior years under Program Element 6.57.02.A/D671, PATRIOT Tactical Vulnerability. Office converted Surface to Air Missile (SAM) JAM, and MIDAS software programs to the Harry Diamond Laboratories computer, developed plotting routines for SAM JAM, and developed two triangulation simulation programs. In September 1977 the Office was chartered by DARCOM and its mission expanded to perform as the DARCOM focal point for CM/CCM actions. Analyzed behavior of low altitude targets in a standoff jamming environment and the effects of false targets on fire platoons' capabilities. The Office subsequently published a management plan for testing electro-optic (EO) systems in battlefield aerosols. Completed Office of the Secretary of Defense (OSD) directed task of investigating Tri-Service Thermal Suppression activities and published a plan for full signature system analysis. Chartered working groups for integrating on-board armored vehicle protection systems, and for investigation of near-millimeter (MM) waved propagation in smoke and chaff. Performed operational security risk assessment of FIREFINDER. Reviewed test plans, provided funds, and established Army signature measurement teams for the Signature Acquisition of Foreign Equipment Oconus Program (SAFE OP). Provided over \$80K to the US Army Night

Program Element: #6.37.49.A

DoD Mission Area: #212 - Electronic Warfare Technology

Title: Technical Vulnerability Reduction

Budget Activity: #2 - Advanced Technology Development

Vision Laboratory (NVL) to upgrade signature data bank with the computer System 2000 software. Led program to evaluate threat to US mines from a magnetic countermeasure (CM) technique. Provided input for planning smoke/limited visibility field test (CRAF II & SMOKE Week II), and assisted PM Smoke/other US Army Materiel Development and Readiness Command (DARCOM) agencies in evaluation of limited visibility problems. Performed as a member of the Smoke Aerosol Steering Group to develop DARCOM technology base program for all smoke related research. Developed Army's plan for multispectral screening program in concert with US Army Armament Research and Development Command (ARRADCOM). Chaired the Propagation Group of DARCOM Near-Millimeter (NM) Technology Review Panel. Represented US Army Electronics Research and Development Command (ERADCOM) in development of report to the Under Secretary on status of millimeter (MM) Wave technology for Army application and in response to the Department of Army Scientific Advisory Panel's recommendations on MM Waves. Performed independent assessments of PATRIOT, Remotely Piloted Vehicle (RPV), Advanced Attack Helicopter (AAH), and the XM-1 tank. Completed studies in communication warfare and Operations Research in electronic warfare (EW). Initiated efforts in response to the Vice Chief of Staff, Army (VCSA) request that a realistic set of battlefield conditions, including naturally degraded environments, and CM be developed for application to all Army operations.

2. FY 1979 Program: Continue development of Army Counter-Countermeasures Management Plan, including preparation of outline "How to" manual which details Countermeasures/Counter-Countermeasures (CM/CCH) functions and interfaces with all Army commands. Key models/scenarios will be identified/examined with the objective of incorporating a realistic battlefield environment. The Office will participate on a priority basis in selected Cost and Operational Effectiveness Analysis (COEA's) to insure CM/CCH are considered. Examinations on Single Channel Ground/Airborne Radio Systems (SINCGARS) as to mutual interference and the relationship of hopping rate to direction finding (DF) susceptibility/accuracy will be initiated. Upgrading of signature data bank and coordination with other service data banks will be effected. Work on producing a valid magnetic signature threat assessment will continue with the intelligence community as well as a follow-up on foreign exploitation opportunities identified in FY 78. The Office will provide funds and participate in the Signatures Acquisition of Foreign Equipment Oconus Program (SAFE-OP). Effects of full spectrum EW on susceptibility of far infrared common modules will be assessed. A study to quantify effectiveness of signature reduction and sensor sensitivity under realistic battlefield conditions for electro-optical (EO) systems will be initiated. An attempt to relate degradation of EO systems performance to host weapon system effectiveness/survivability will be conducted. Sensitivity of Image Intensifier to laser threat will be investigated. Susceptibility of EO systems to radio frequency interference (RFI), electromagnetic pulse (EMP), and on-board laser radiation will be reviewed. Participation in smoke related working groups will continue. EO jammers vs laser guided weapons will be war-gamed. A series of susceptibility studies for priority weapons systems regarding multispectral screening will begin. Activity in millimeter wave technology and radar tech base will continue. Susceptibilities of major sensor nets/Command, Control, and Communications (C3) systems CM (current and future) will be examined. New requirement documents and product improvements (PIP) will be reviewed. The Office will participate in various studies and analyses of SINCGARS, Surveillance Target Acquisition Radar for Tank Location and Engagement (STARTLE), Heliborne, Laser, Fire and Forget Missile/Advanced Attack Helicopter (HELLFIRE/AAH), COOPERHEAD/CLLD (Ground Laser Locator Designator), Battlefield Surveillance Target Acquisition Radar (BSTAR), TPQ-37, Standoff Target Acquisition System (SOTAS), Advanced Heavy Antitank Weapon System (AHWS), XM-1, Remotely Piloted Vehicles (RPV), and PATRIOT. An analysis of the effect of IFF (identification friend or foe) on host system susceptibility will be conducted.



Program Element: #6.37.49.A

Title: Technical Vulnerability Reduction  
Budget Activity: #2 - Advanced Technology Development

D.3 Mission Area: #212 - Electronic Warfare Technology

3. FY 1980 Planned Program: A "How To" manual for incorporating realistic battlefield conditions into weapon system development will be completed and regulations modified as required. Work to incorporate countermeasures/counter-countermeasures (CM/CCM) into models will continue with US Army Training and Doctrine Command (TRADOC), US Army Intelligence and Security Command (INSCOM), and US Army Materiel Development and Readiness Command (DARCOM). Signature bank will be finalized and methodology for upgrading will be developed. Support of XM-1 tank program in the signature area will continue. Studies on CCM for various types of electro-optical (EO) devices will be conducted and effects of updated threat investigated. CM susceptibility of television systems, Forward Looking Infrared (FLIR), Tactical Air Defense System (TADS), and Pilots Night Vision System (PNVS) will be analyzed. Vulnerability assessments of Heliborne, Laser, Fire and Forget (HELLFIRE) seeker candidates and TADS will be performed. Multispectral screening efforts will include susceptibility studies for new systems. The millimeter (MM) wave technology efforts will continue at the FY79 level. The effect of new technologies, such as artificial intelligence/surface acoustic wave (SAW) devices/fault tolerant networks, on CM/CCM processes related to command, control, and communication (C3) systems will be examined. Techniques for assessing effects of signature reduction on XM-1 will be extended to other armored vehicles. New requirements documents and product improvement (PIP) will be reviewed. Full vulnerability assessment of Stand-Off Target Acquisition System (SOTAS), Single Channel Ground/Airborne Radio System (STINGARS), Division Air Defense System (DIVADS), and HELLFIRE/AMH (Advanced Attack Helicopter) will be conducted with Combined Arms Combat Development Activity (CACDA) and US Army Training and Doctrine Command Systems Analysis Activity (TRASANA). The Office of the Secretary of Defense directed study effort on SOTAS, Remotely Piloted Vehicles (RPV), and PATRIOT will examine the probable response threat resulting from successful fielding of these systems and define appropriate CCM techniques. Contractor support will account for the majority of this \$1 million effort. CCM alternatives for Surveillance Target Acquisition Radar for Tank Location and Engagement (STARTLE) will be determined and evaluation of options begun.

4. FY 1981 Planned Program: Continue efforts to incorporate CM into models and scenarios. Signature data bank will be updated. Studies of CCM for various EO devices will be continued and updated threats investigated. Investigation of laser systems vulnerability will continue with Office of Missile Electronic Warfare/Night Vision Electro-Optics Laboratory (OMEW/NVEOL). Multispectral screening vulnerability assessment capability will be improved and threat response information evaluated. CCM concepts for MM wave techniques will be expanded to newer systems. New emphasis will be made on vulnerability of computers and microprocessors in C3 applications. The Office will ensure that DARCOM Nuclear Weapons Effects (NWE) hardening efforts are integrated into CM/CCM evaluations. Review of requirements documents and PIP will continue. Input to tests, studies, COEA and decision points for critical systems will be provided.

5. Program to Completion: This is a continuing program.

# FY 1980 RDTF CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.50.A

DOD Mission Area: #221 - Medicine and Life Sciences

Title: Drug & Vaccine Development

Budget Activity: #2 - Advanced Technology Development

## A. RESOURCES (PROJECT LISTING): (\$ in thousands)

Project Number	Title	FY 1978 Actual	FY 1979 Estimate	FY 1980 Estimate	FY 1981 Estimate	Additional to Completion Continuing	Total Estimated Costs Not Applicable
A808	Drug & Vaccine Development	0	1000	2550	3623	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The ability to prevent or treat infectious disease having major military impact depends upon the ability to produce pilot lots of vaccines and/or drugs and to conduct appropriate field testing prior to final fielding of the items. Since diseases of military concern are not of general civilian public health importance in US, commercial production base for such vaccines or drugs does not exist; no civilian agency is prepared to conduct large scale field trials. Requirement exists to maintain limited pilot lot production with commercial scale-up translational ability to meet DoD contingency requirements and to conduct necessary field trials prior to type classification/stockage of such items.

C. BASIS FOR FY 1980 RDTF REQUEST: The logical progression in the development of drugs and vaccines effective for preventing and treating militarily important infectious diseases requires preclinical and clinical evaluation in humans. This new program will effectively fulfill this requirement. This program is essential for final development of drugs and vaccines to be stocked and used within the DOD system.

## D. BASIS FOR CHANGE BETWEEN FY 1980 AND FY 1979 CONGRESSIONAL DESCRIPTIVE SUMMARIES: (\$ in thousands)

RDTF	FY 1978	FY 1979	FY 1980	Additional to Completion	Total Estimated Cost	Not Applicable
Funds (as shown in FY 1979 submission)	0	1000	1639	Continuing		

Increase in FY 1980 funds reflects support of the Industrial base for production of pilot lot vaccines against exotic or potential Biological Warfare (BW) agents. This effort includes field testing and potential for rapid response production. Vaccine development encompasses results of studies performed at the US Army Medical Research Institute of Infectious Diseases (USAMRIID), Ft. Detrick, MD, and the Walter Reed Army Institute of Research (WRAIR), Washington, DC.

E. OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.37.50.A

DoD Mission Area: #221 - Medicine and Life Sciences

Title: Drug & Vaccine Development

Budget Activity: #2 - Advanced Technology Development

**F. DETAILED BACKGROUND AND DESCRIPTION:** The military community has a continuing requirement for safe and effective drugs and vaccines to protect soldiers against endemic and epidemic diseases which decrement training, mobilization, or combat operations. In the interest of national security, military personnel must be prepared to engage in combat in any geopolitical region. Therefore, to assure strategic mobility, drugs and vaccines must be available to protect against diseases encountered should contingency plans be activated. This program focuses on essential advanced developmental studies for preventive and curative drugs and vaccines used for military personnel. These products must be effective against parasitic, bacterial, rickettsial, and virus diseases. Candidate drugs and vaccines thus developed must undergo necessary advanced pharmacologic and toxicologic evaluations required by the Food and Drug Administration, Bureau of Biologics, and Department of Defense. These prophylactic and therapeutic products are then tested under natural conditions in large-scale field trials prior to stocking in the DOD system.

**G. RELATED ACTIVITIES:** Related Army studies are performed under Program Elements/DA Projects 6.11.02.A/BS01, Basic Research on *Military Injury and Diseases*; 6.11.02.A/BS03, Medical Defense Against Biological Agents; and 6.27.70.A/A841, Medical Defense Against Biological Agents. Complementary infectious disease research conducted by the Navy, National Institutes of Health, Department of Agriculture, and the Center for Disease Control is pertinent to this program element. However, the Army drug and vaccine development program focuses on preventing or treating militarily important diseases which cause morbidity or mortality of troops in training, mobilization, or combat operations. Army representation on Department of Defense coordinating committees and other intergovernmental agency coordination councils and insures coordination at the working and administrative levels to prevent duplication of effort. Army scientists serve as consultants with the World Health Organization and have access to this organization's studies, reports, and publications. Other coordination is accomplished by personal contacts at the operating level, by site visits by project officers, organization of technical symposia on selected topics, routine exchange of reports among staff and laboratory organizations, open publication of results in scientific journals, and distribution of research and technology resumés.

**H. WORK PERFORMED BY:** Approximately 35% of the research will be conducted by the in-house laboratories of the Walter Reed Army Institute of Research, Washington, DC, and field units in Thailand, Kenya, and Brazil. The remaining 65% of the work will be conducted by extramural contracts awarded to the University of Hawaii, Honolulu, HI; Biomed, Inc., Washington, DC; and Salk Institute, San Diego, CA.

**I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:**

1. **FY 1978 and Prior Accomplishments:** Not applicable.
2. **FY 1979 Program:** Evaluate two or three drugs showing promise in preclinical and clinical studies as prophylactic and/or therapeutic agents for drug-resistant malaria in limited field trials. Study several antiparasitic drugs in clinical tests for prevention and treatment of leishmaniasis, a serious disease occurring in troops conducting operations in endemic areas.



Program Element: #6.37.50.A  
DoD Mission Area: #221 - Medicine and Life Sciences

Title: Drug & Vaccine Development  
Budget Activity: #2 - Advanced Technology Development

3. FY 1980 Planned Program: Conduct field trial of adenovirus 21 vaccine for recruit protection to ascertain its effectiveness in troop populations. Recommended vaccine for standard use when development is completed. Evaluate efficacy of antiparasitic drugs in clinical tests. Perform safety tests on a candidate Dengue type II vaccine and evaluate efficacy in man. Exploratory development program for potential BW vaccines depends on ability to produce vaccines on commercial scale; the industrial base for exotic vaccines is nonexistent. This program maintains the ability to produce pilot lot BW vaccines for field trials, and the potential for rapid response production in response to contingency planning.
4. FY 1981 Planned Program: Evaluate antimalaria drugs under limited and comprehensive field tests. Submit most promising drugs for Food and Drug Administration approval and for stocking in DOD supply. Recommend vaccine for standard use when development is complete. Conduct safety and efficacy tests for an antileishmanial drug. Meningococcal meningitis has a serious impact on recruits and troops during mobilization. Conduct clinical trials on a new group B vaccine before fielding and stockage in the DOD system.
5. Program to Completion: This is a continuing program.

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